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OFFICE OF CHEMICAL SAFETY
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Introduction

As part of Registration Review, the Pesticide Re-Evaluation Division (PRD) of OPP has requested that HED evaluate the hazard and exposure data and conduct occupational and residential exposure assessments, as needed, to estimate the risk to human health that will result from the registered uses of permethrin. This memorandum serves as HED's Registration Review occupational and residential exposure and risk assessment of the registered conventional uses of permethrin.

It is HED policy to use the best available data to assess exposure. Several sources of generic data were used in this assessment as surrogate data in the absence of chemical-specific data, including: Pesticide Handlers Exposure Database Version 1.1 (PHED 1.1); the Agricultural Handler Exposure Task Force (AHETF) database; the Outdoor Residential Exposure Task Force (ORETF) database; ExpoSAC Policy 14 (SOPs for Seed Treatment); the Residential SOPs **(**Treated, Lawns/Turf, Indoor Environments, Insect Repellents, Outdoor Fogging and Misting Systems, Treated Paints and Preservatives, and Treated Pets**),** other registrant-submitted exposure monitoring studies (MRID #: 448524-02, 448524-03, 437557-01, 449555-01, 48135326, 4407668-12, 48135325, 44339801, 49602401, 45773201, 45250702/45167201, 45528801, 44439901/45519601, 45333401, 44433303, 44459801/41054701/44739301, 44433302, 44339801, and 43600102); and the Residential Exposure Joint Venture (REJV) National Pesticide Survey. Some of these data are proprietary, and subject to the data protection provisions of the *Federal Insecticide, Fungicide, and Rodenticide Act (*FIFRA).

Note: This memorandum was reviewed by the Exposure Science Advisory Committee (ExpoSAC) on May 18, 2017.

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1.0 Executive Summary

Permethrin [(3-phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane-1-carboxylate] is a broad-spectrum pyrethroid insecticide that is currently registered in the US with 121 companies on over 600 product labels for a wide variety of indoor and outdoor residential, institutional, and industrial settings, agricultural crops, animal applications, and public health uses. Permethrin is a Type I pyrethroid, and, like other pyrethroids, causes neurotoxicity from interaction with sodium channels leading to clinical signs of neurotoxicity.

Permethrin is formulated as an emulsifiable concentrate (EC), dry flowable (DF), wettable powder (WP) (including water soluble bags), granule (G), dust (D), as well as a number of ready to use (RTU) formulations (e.g., aerosol cans, foggers, trigger pump sprayers, ear tags, hose-end sprayers, paints). In addition, there is one registered Section 18 emergency exemption registration for application to military aircraft's cabin, crew, and cargo areas with an aerosol space spray. Registered permethrin occupational labels require handlers wear baseline attire (long sleeved shirt, long pants, shoes and socks) and chemical resistant gloves in consideration of potential exposure. Additional personal protection equipment (PPE) is required for some permethrin formulations (e.g., coveralls, National Institutes for Occupational Safety and Health (NIOSH) approved respirators, etc.) and is further detailed in section 8.1 under *Mitigation/Personal Protective Equipment*.

Permethrin is a restricted use pesticide (RUP) due to toxicity to fish and aquatic organisms for all wide area agricultural outdoor broadcast applications including agricultural crops, golf courses, and nurseries. All RUP product labels stipulate a restricted entry interval (REI) of 12 hours with the exception of EPA Reg. No. 53883-72 which requires a 24-hour REI.

<u>Hazard Characterization</u>
The toxicology database for permethrin is considered complete with respect to guideline toxicity studies. Permethrin is a Type I pyrethroid, and, like other pyrethroids, causes neurotoxicity from interaction with sodium channels leading to clinical signs of neurotoxicity. The toxicity profiles for all the pyrethroids are very similarly marked by rapid absorption, metabolism, and time-to-peak effect. The single dose and repeat dosing permethrin studies show that repeat exposures do not result in lower PODs (i.e. there is no evidence of increasing toxicity with an increased duration of exposure). Therefore, for purpose of exposure assessments, only single day risk assessments need to be conducted for permethrin, and these are protective of scenarios in which exposure occurs for multiple days.

In conjunction with the completion of the pyrethroid cumulative risk assessment (K. Whitby, D394576, 10/4/2011), HED determined that the Food Quality Protection Act Safety Factor (FQPA SF) can be reduced to 1X for adults and children over the age of 6 years. The agency is retaining a 3x FQPA Safety Factor to protect for exposures of children <6 years of age based on the increased quantitative susceptibility seen in studies on pyrethroid pharmacokinetics (PKs) and the increased quantitative juvenile susceptibility observed in high dose studies in the literature.

Short-Term Incidental Oral Endpoint: An incidental oral POD of 44 mg/kg was selected from the Wolansky acute rat study because of the overall robust nature of the study, and it is protective of all effects observed in the toxicology database. The traditional uncertainty factors of 10X for inter-species variability and 10X for intra-species variability were applied to the incidental oral risk assessments in addition to the FQPA SF of 3X for children < 6 years old, and reduced to 1X for adults and children ≥ 6 years. Therefore, the incidental oral level of concern (LOC) is equal to an MOE of 300 for children < 6 years old, and 100 for ≥ 6 years old.

Short-Term Dermal Endpoint: Dermal endpoints were not selected for permethrin as no toxicity was observed in the rat dermal study identified and there are no concerns for susceptibility. This lack of toxicity is also supported by the low dermal absorption of permethrin (i.e., 3.3%). Low dermal absorption is consistent with the pyrethroid class as a whole.

Short-Term Inhalation Endpoints: An inhalation POD of 0.042 mg/L was selected based on the 15-day inhalation study in rats showing clinical signs (tremors and hypersensitivity). For the inhalation toxicity study with permethrin, a regional-deposited-dose ratio (RDDR) was estimated at 3.142. The traditional uncertainty factor of 10X for intra-species variability was applied to the inhalation risk assessments, while the inter-species extrapolation factor was reduced to 3X based on the use of the human equivalent doses (HEDs) to assess inhalation exposure and risk. In addition, the FQPA SF of 3X was retained for children < 6 years old, and reduced to 1X for adults and children ≥ 6 years. Therefore, the inhalation LOC is equal to an MOE of 100 for children < 6 years old, and 30 for adults and children ≥ 6 years old.

Combined endpoints: Since the PODs chosen to evaluate the inhalation and incidental oral exposure routes share a common toxicological endpoint, risk estimates have been combined as appropriate for those routes. A total aggregated risk index (ARI) was used for children <6 years old since the LOCs for inhalation (100) and incidental oral exposure (300) are different. The target ARI is 1; therefore, ARIs of less than 1 are risk estimates of concern.

Cancer Quantification (Adults): Permethrin is classified as "Likely to be Carcinogenic to Humans" based on female mouse lung adenoma and/or carcinoma combined tumor rates. Q_1^* $(mg/kg/day)^{-1} = 9.567 \times 10^{-3}$.

Dermal Absorption Factor: A dermal absorption factor of 3.3% was used in the cancer calculations when estimating a dermal dose.

Exposure Profile

Occupational and residential handler dermal and inhalation exposure and post-application dermal, inhalation, and incidental oral exposures are anticipated for permethrin usage. However, as there is no dermal hazard identified, a non-cancer quantitative dermal assessment was not conducted. For all registered uses, there is a potential for short-term (1 to 30 days) and intermediate term (1 to 6 months) exposure to permethrin during mixing, loading, applying, and other handling tasks. However, due to the rapid onset toxicity of permethrin, only short-term non-cancer risks have been quantitatively assessed. All assessments were completed assuming the labeled maximum single application rate for each scenario. Chronic exposure in the form of repeated exposures over a long period of time is not expected for the registered uses; however,

for the purposes of assessing cancer risk, lifetime average exposures are quantified. Non-occupational spray drift exposure is anticipated.

Residential Exposure and Risk

Residential handler and post-application exposures are anticipated from the use of permethrin products. A screening-level approach was used for the assessment of residential exposures by evaluating only the maximum registered application rates for all possible residential exposure scenarios of permethrin.

All residential scenarios for aggregate risk assessment have been updated in this document since the previous permethrin exposure assessment (C. Smith, 01-APR-2009, D357566) and now reflects HED's 2012 Residential SOPs[1] along with policy changes for body weight assumptions. Furthermore, the inhalation human equivalent concentrations (HECs) have been updated since the previous assessment while the dermal hazard has been removed based on an updated study with no dermal hazard identified.

Residential Handler Exposure:

All screening-level non-cancer residential handler inhalation risks estimates are not of concern with MOEs ranging from 370 to 770,000 (adult inhalation LOC = 30).

Since there is no non-cancer dermal hazard for permethrin, the short-term (non-cancer) handler assessment includes only inhalation exposures. For the cancer assessment, both dermal and inhalation exposures are assessed.

Residential handler cancer (dermal + inhalation) risk estimates range from 3×10^{-10} to 2×10^{-6} with the greatest cancer risk estimate resulting from mixing/loading/applying liquid applications with a backpack sprayer to gardens/trees/ornamentals.

Residential Post-Application Exposure:

Several available sources of chemical-specific exposure data were used for residential post-application exposure assessment. Results from a chemical specific liquid formulation turf transferable residue (TTR) study were incorporated into the post-application assessment for turf. Liquid formulation pyrethroid specific dislodgeable foliar residue (DFR) studies were used for post-application exposure in gardens. Additionally, chemical-specific residue transfer studies from dogs and military battle dress uniforms (BDUs) were used to refine post-application exposure risk estimates. The post-application exposure scenarios, hand-to-mouth and inhalation exposures, for children 1 to < 2 years old were combined since effects were similar across those routes. This combination should be considered a protective estimate of children's exposure.

The majority of the non-cancer post-application risk estimates result in MOEs greater than the LOC and are not of concern (i.e., adult and children ≥ 6 years old inhalation MOEs are > 30; children < 6 years old inhalation MOEs are > 100; and children < 6 years old incidental oral MOEs are >300). However, children 3 to < 6 years old present risk estimates of concern from

[1] Available: http://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide

inhalation exposures resulting from indoor barn misting systems following "initial cleanout" application rates with an ARI of 0.54 driven by an inhalation MOE of 54 (LOC = 100).

Adult residential post-application exposure cancer risk estimates range from 9.1×10^{-9} to 5×10^{-5} with the greatest cancer risk estimate resulting from contact with small cats treated with liquid formulations of permethrin (non-spot-on).

Non-Occupational Spray Drift Exposure and Risk

A quantitative non-occupational spray drift assessment for permethrin is not required because the maximum application rate to a crop/target site (1.6 lbs ai/A for forestry applications) multiplied by the adjustment factor for drift of 0.26 is less than the maximum direct spray residential turf application rate (0.87 lb ai/A) for any permethrin products. There were no risks of concern for the residential turf assessment; therefore, the assessment to residues on turf is protective of exposure to the residue from spray drift.

Occupational Exposure and Risk

Occupational handler and post-application dermal and inhalation exposures are anticipated from the use of permethrin products. However, as there is no dermal hazard identified, a non-cancer quantitative dermal assessment was not conducted. A screening-level approach was used for the assessment of occupational exposures by evaluation of the maximum application rate for all possible occupational exposure scenarios of permethrin.

Occupational Handler Non-Cancer Exposure and Risk Estimates

All screening-level non-cancer occupational handler inhalation risks estimated are not of concern using engineering controls (for aerial applicators) or baseline PPE and no respirator, with MOEs ranging from 31 to 240,000,000 (LOC < 30).

Since there is no non-cancer dermal hazard for permethrin, the short-term (non-cancer) handler assessment includes only inhalation exposures. For the cancer assessment, both dermal and inhalation exposures are assessed.

Occupational Handler Agricultural Uses Cancer Exposure and Risk Estimates

The cancer occupational handler risk estimates for the currently registered crops and crop groups ranged from 1×10^{-8} to 5×10^{-5} to for private handlers (10 days of exposure/year) and 3×10^{-8} to 2×10^{-4} for commercial handlers (30 days of exposure/year).

Occupational Handler Non-Agricultural Uses Cancer Exposure and Risk Estimates

The cancer occupational handler risk estimates for the registered use sites ranged from 2×10^{-9} to 1×10^{-3} for commercial handlers.

Occupational Post-Application Exposure

There is potential for post-application dermal exposure from agricultural applications, however there is no short- or intermediate-term dermal hazard and therefore they were not quantitatively assessed. The potential for dermal or inhalation post-application exposure to mosquito adulticide applicators is anticipated to be negligible since they are not expected to be present in treated areas after application. However, there is potential for indirect dermal post-application exposure

to re-entry workers in agricultural fields under the airspace receiving public health mosquito vector control treatment with permethrin. There is no dermal hazard identified, therefore a non-cancer quantitative dermal assessment was not conducted. Based on the Agency's current practices, a quantitative occupational post-application inhalation exposure assessment was not performed for re-entry workers exposed to indirect residues of permethrin resulting from public health uses or registered agricultural uses. If new policies or procedures are put into place, the Agency may revisit the need for a quantitative occupational post-application inhalation exposure assessment for permethrin.

Commercial applicators do not typically return to the treated areas after non-agricultural commercial pesticide applications (sites such as warehouses, food handling establishments, hotels, lawns/landscaping etc.) and thus an occupational indoor post-application exposure assessment was not performed for commercial applicators.

A quantitative cancer post-application assessment was conducted with all agricultural application rates greater than the adult mosquitocide ULV application rates (0.007 lbs ai/acre). Therefore, the existing occupational post-application cancer exposure assessment for agricultural uses is considered protective of mosquito adulticide public health use ULV applications which could potentially be applied over agricultural areas. Occupational post-application cancer risk estimates for the registered agricultural uses ranged from 1×10^{-9} to 4×10^{-6} using the average 30-day dose. The forestry post-application activity of hand set irrigation result in the highest cancer risk estimate.

Human Studies Review

This risk assessment relies in part on data from studies in which adult human subjects were intentionally exposed to a pesticide or other chemical. These data, which include studies from PHED 1.1; the AHETF database; and the Residential SOPs (Treated, Lawns/Turf, Indoor Environments, Insect Repellents, Outdoor Fogging and Misting Systems, Treated Paints and Preservatives, and Treated Pets), other registrant-submitted exposure monitoring studies (MRID: 448524-02, 448524-03, 437557-01, 449555-01, 48135326, 4407668-12, and 48135325); and the Residential Exposure Joint Venture (REJV) National Pesticide Survey; are (1) subject to ethics review pursuant to 40 CFR 26, (2) have received that review, and (3) are compliant with applicable ethics requirements. For certain studies, the ethics review may have included review by the Human Studies Review Board. Descriptions of data sources, as well as guidance on their use, can be found at the Agency website[2].

2.0 Risk Assessment Conclusions and Recommendations

2.1 Summary of Risk Estimates

Non Cancer Risk Estimates

[2] http://www.epa.gov/pesticides/science/handler-exposure-data.html and http://www.epa.gov/pesticides/science/post-app-exposure-data.html

Based on a screening-level risk assessment approach, all residential non-cancer risk estimates were not of concern for permethrin, except one residential non-cancer risk estimate:

Residential Post-Application Risks of Concern:

- Children 3 to < 6 years old inhalation exposure from indoor barn automatic misting systems using initial cleanout application rates (0.50 oz ai/1,000 ft^3) (MOE = 54; LOC = 100).

Cancer Risk Estimates

Residential Cancer Risk Estimates

- Residential handler cancer (dermal + inhalation) risk estimates range from 3×10^{-10} to 2×10^{-6}.
- Residential post-application exposure cancer risks range from 9.1×10^{-9} to 5×10^{-5}.

Occupational Handler Agricultural Uses Cancer Exposure and Risk Estimates
The cancer occupational handler risk estimates for the currently registered crops and crop groups ranged from 1×10^{-8} to 5×10^{-5} to for private handlers (10 days of exposure/year) and 3×10^{-8} to 2×10^{-4} for commercial handlers (30 days of exposure/year).

Occupational Handler Non-Agricultural Uses Cancer Exposure and Risk Estimates
The cancer occupational handler risk estimates for the registered use sites ranged from 2×10^{-9} to 1×10^{-3} for commercial handlers.

Occupational Post-Application Cancer Risk Estimates
Occupational post-application cancer risk estimates for the registered agricultural uses ranged from 1×10^{-9} to 4×10^{-6} using the average 30-day dose. The forestry post-application activity of hand set irrigation result in the highest cancer risk estimate.

2.2 Label Recommendations for Residential Assessment

No specific label recommendations are being made; however, HED notes that there are residential post-application scenarios for registered uses that have non-cancer risk estimates of concern and cancer risk estimates where potential mitigation may impact label language.

2.3 Label Recommendations for Occupational Assessment

No specific label recommendations are being made, however, HED notes that there are several occupational handler and post-application scenarios for registered uses that have cancer risk estimates which may impact potential mitigation.

2.4 Data Deficiencies and Requirements

None

3.0 Hazard Characterization

The permethrin endpoints/ PODs have been updated since the previous risk assessment (C. Smith, D357566, 01-AUG-2009) to reflect the following changes:

- There is no longer a dermal hazard for permethrin.
- The HECs for systemic effects have been re-calculated since the previous assessment using the updated HEC calculator.

Acute Toxicity

Permethrin is classified as having low acute toxicity via the oral, dermal, and inhalation routes (Toxicity Category III or IV). It was found to be a slight eye and dermal irritant, but is not a skin sensitizer. Tables 3.1 presents a summary of the acute toxicity information for permethrin.

Table 3.1. Acute Toxicity Profile – Permethrin

Guideline No.	Study Type	MRID(s)	Results	Toxicity Category
870.1100	Acute oral toxicity in Rats	242899	LD_{50} = 3580 mg/kg (M) 2280 mg/kg (F)	III
870.1200	Acute dermal toxicity in Rabbits	242899	LD_{50} >2000 mg/kg	III
870.1300	Acute inhalation toxicity in Rats	45804302	LC50 >2.08 mg/L	IV
870.2400	Acute eye irritation in Rabbits	242899	Irritation 24-48 hrs. All cleared by 72 hrs.	III
870.2500	Acute dermal irritation in Rabbits	242899	All irritation cleared by 48 hrs.	IV
870.2600	Skin sensitization in Guinea Pigs	EPA Memo [1]	Non-sensitizer[2]	Not Applicable

1 EPA Memorandum (June 13, 1995) "Permethrin: Review of a series 81-6 dermal sensitization study (guinea pig maximization test) and a series 85-2 dermal penetration study."
2 Based on a weight of evidence evaluation of other sensitization study data do not indicate that permethrin should be regulated as a potential sensitizer.

Toxicological PODs Used for Risk Assessment

Permethrin is a Type I pyrethroid, and, like other pyrethroids, causes neurotoxicity from interaction with sodium channels leading to clinical signs of neurotoxicity. The toxicity profiles for all the pyrethroids are very similarly marked by rapid absorption, metabolism, and time-to-peak effect. The single dose and repeat dosing permethrin studies show that repeat exposures do not result in lower PODs (i.e. there is no evidence of increasing toxicity with an increased duration of exposure). Therefore, for purpose of exposure assessments, only single day risk assessments need to be conducted for permethrin, and these are protective of scenarios in which exposure occurs for multiple days.

In conjunction with the completion of the pyrethroid cumulative risk assessment (K.Whitby, D394576, 10/4/2011), HED determined that the Food Quality Protection Act Safety Factor (FQPA SF) can be reduced to 1X for adults and children over the age of 6 years. The agency is retaining a 3x FQPA Safety Factor to protect for exposures of children <6 years of age based on

the increased quantitative susceptibility seen in studies on pyrethroid PKs and the increased quantitative juvenile susceptibility observed in high dose studies in the literature.

Short-term Incidental Oral: The oral benchmark dose level ($BMDL_{1SD}$) of 44 mg/kg from the Wolansky acute rat study is being used for this endpoint because of the overall robust nature of the study, and it is protective of all effects observed in the toxicology database. The traditional uncertainty factors of 10X for inter-species variability and 10X for intra-species variability were applied to the incidental oral risk assessments in addition to the FQPA SF of 3X for children < 6 years old. Therefore, the incidental oral LOC is equal to an MOE of 300 for children < 6 years old.

Short-term Dermal: No dermal assessment is being conducted for permethrin. No toxicity was observed in the rat dermal study with no dermal hazard identified. This lack of toxicity is also supported by the low dermal absorption of permethrin (<5%). Low dermal absorption is consistent with the pyrethroid class as a whole.

Short-term Inhalation: A 15-day inhalation study in rat resulted in a no observed adverse effect level (NOAEL) and lowest observed adverse effect level (LOAEL) of 0.042 and 0.53 mg/L based on clinical signs (tremors and hypersensitivity). The methods and dosimetry equations described in EPA's reference concentration (RfC) guidance (1994) are suited for calculating HECs based on the inhalation toxicity point of departure (NOAEL, LOAEL, or benchmark dose level (BMDL)) for use in MOE calculations. The regional-deposited-dose ratio (RDDR), which accounts for the particulate diameter (mass median aerodynamic diameter [MMAD] and geometric standard deviation [σ_g] of aerosols), can be used to estimate the different dose fractions deposited along the respiratory tract. The RDDR is also based on interspecies differences in ventilation and respiratory-tract surface areas. Thus, the RDDR can be used to adjust an observed inhalation particulate exposure of an animal to the predicted inhalation exposure for a human. For the inhalation toxicity study with permethrin, an RDDR was estimated at 3.142. The traditional uncertainty factor of 10X for intra-species variability was applied to the inhalation risk assessments, while the inter-species extrapolation factor was reduced to 3X based on the use of the human equivalent doses (HEDs) to asses inhalation exposure and risk. In addition, the FQPA SF of 3X was retained for children < 6 years old, and reduced to 1X for adults and children ≥ 6 years. Therefore, the inhalation LOC is equal to an MOE of 100 for children < 6 years old, and 30 for adults and children ≥ 6 years old.

Permethrin is classified as "Likely to be Carcinogenic to Humans" based on female mouse lung adenoma and/or carcinoma combined tumor rates. Q_1^* $(mg/kg/day)^{-1} = 9.567 \times 10^{-3}$.

A summary of the toxicological doses and endpoints for occupational and residential exposure scenarios are provided in Tables 3.2 and 3.3.

Table 3.2. Summary of Toxicological Doses and Endpoints for Permethrin for use in Non-Occupational and Occupational Human Health Risk Assessments.				
Exposure Scenario	**Point of Departure**	**Uncertainty/FQPA Safety Factors**	**RfD, PAD, Level of Concern for Risk Assessment**	**Study and Toxicological Effects**
Acute Dietary- (< 6 years old)	Wolansky $BMDL_{1SD}$ = 44 mg/kg	UF_A = 10X UF_H = 10X FQPA SF = 3X	Acute RfD = 0.44 mg/kg aPAD =0.147 mg/kg/day	Wolansky BMD_{1SD} = 63 mg/kg based on decreased motor activity
Incidental Oral (Short-term)	Wolansky $BMDL_{1SD}$ = 44 mg/kg	UF_A = 10X UF_H = 10X FQPA SF = 3X	Residential LOC for MOE = 300	Wolansky BMD_{1SD} = 63 mg/kg based on decreased motor activity
Dermal (short-term; all populations)	No assessment recommended. No effects observed in the dermal toxicity study, and low dermal absorption based on dermal penetration studies. Using the oral data with the dermal penetration factor would lead to a POD near the limit dose.			
Inhalation (Short-term; ≥ 6 years old)	Inhalation NOAEL= 0.042 mg/l	UF_A = 3X UF_H = 10X FQPA SF = 1X	Occupational/Residential LOC for MOE = 30	15-Day Inhalation Toxicity (rat) LOAEL = 0.583 mg/l based on body tremors and hypersensitivity to noise.
Inhalation (Short-term; < 6 years old)	Inhalation NOAEL= 0.042 mg/l	UF_A = 3X UF_H = 10X FQPA SF = 3X	Residential LOC for MOE = 100	15-Day Inhalation Toxicity (rat) LOAEL = 0.583 mg/l based on body tremors and hypersensitivity to noise.
Cancer (oral, dermal, inhalation)	Classification: "Likely to be Carcinogenic to Humans" based on female mouse lung adenoma and/or carcinoma combined tumor rates. Q_1* $(mg/kg/day)^{-1} = 9.567 \times 10^{-3}$			

Point of Departure (POD) = A data point or an estimated point that is derived from observed dose-response data and used to mark the beginning of extrapolation to determine risk associated with lower environmentally relevant human exposures. NOAEL = no observed adverse effect level. LOAEL = lowest observed adverse effect level. UF = uncertainty factor. UF_A = extrapolation from animal to human (interspecies). UF_H = potential variation in sensitivity among members of the human

Table 3.3. Summary of HEC/HED Values[1]						
Population	**Scenario**	**Tox duration adjustment**		**HEC**		**HED (mg/kg-day)**
		hr/day	**day/wk**	**mg/L**	**mg/m3**	
Occupational	Handler	0.75	1	0.099	98.973	9.366
Residential	Handler	NA	NA	0.132	131.964	3.122
	Outdoor post-application	NA	NA	0.132	131.964	3.590
	Indoor Post-application	NA	7	0.132	131.964	3.122
	Bystander	24	7	0.033	32.991	NA

HEC =human-equivalent concentration; HED =human-equivalent dose.
HEC =NOAEL*(daily duration adjustment) *weekly daily duration adjustment *RDDR*
HED = HEC x human specific conversion factor x activity factor for the exposure scenario x daily duration

Absorption (Short-Term):
Since the short-term inhalation POD was based on a route-specific toxicity study, no absorption factor was necessary to estimate exposure.

Dermal Absorption Factor (Used for Cancer Risk Estimates):
Data are available to allow for use of the triple pack approach, including an *in vivo* rat dermal penetration study and an *in vitro* dermal absorption study using both rat and human skin. The *in vivo* dermal penetration study in rats (MRID 43169001) indicated a dermal absorption factor of 21.7%, at 10 hours after administration. The comparative *in vitro* dermal penetration study using human and rat skin (MRID 47514801) showed that 18% of an applied dose was absorbed through rat skin and 2.3% through human skin, which indicates that *in vitro* rat skin is 6.6 times more permeable than *in vitro* human skin. Therefore, a dermal absorption factor of 21.7/ 6.6 = 3.3% is considered appropriate for cancer risk assessment.

Body Weight
The standard body weight for the general population (80 kg) was used for all exposure scenarios covered in this risk assessment since the endpoints selected were not developmental and/or fetal effects. A standard body weight was used for all exposure scenarios for children covered in this risk assessment as follows:

- Children 1 to < 2 years old: 11 kg
- Children 3 to < 6 years old: 19 kg

4.0 Use Profile

Permethrin is registered to control insects in indoor and outdoor residential, institutional (e.g., hotels, theatres, restaurants, hospitals), industrial settings (e.g., industrial buildings, poultry houses, warehouses), and on agricultural crops; and is registered as a seed treatment and for public health uses. It can be used indoors as a direct spot treatment (with some residential site restrictions), crack and crevice application, aerosol space spray, and total release fogger. Outdoor applications can be made as a direct or spot treatment to buildings/household perimeters, landscaping, or lawns via aerosol cans, handheld equipment, and trigger sprays. Outdoor applications may also be applied via ultra-low volume (ULV) thermal fogger and automatic spraying systems. Agricultural crop applications can be made as a broadcast spray or spot treatment via ground, air, and handheld equipment (e.g., aerial, airblast, backpack, chemigation, groundboom, manually/mechanically pressurized handgun, tractor drawn spreader, and truck mounted fogger). In addition, there is a registered Section 18 emergency exemption registration for application to military aircraft's cabin, crew, and cargo areas with an aerosol space spray.

Permethrin is also registered for direct use on fabric (e.g., personal clothing, camping gear, mattresses), dogs, horses, and livestock (including beef/dairy cattle, goats, sheep, poultry, and swine). Permethrin products are formulated as emulsifiable concentrates, dry flowables, wettable powders (including water soluble bags), granules, dusts, as well as a number of ready to use (RTU) formulations (e.g., aerosol cans, foggers, trigger pump sprayers, ear tags, hose-end sprayers, and paints).

Permethrin may be applied as an ULV vector mosquito adulticide by ground (truck mounted fogger), aerial, and handheld equipment. These mosquito vector control products are only to be applied by federal, state, tribal or local government officials responsible for public health and adult mosquito control.

A screening-level approach was used for assessment of occupational and residential exposures by evaluation of the maximum application rate for all possible residential exposure scenarios of permethrin. The updated use pattern tables were compiled by cross referencing the previous risk assessment's use pattern table (C. Smith, 04-APR-2009, D325428) with a summary of resulting label changes[3], and representative labels for unique uses.

Registered occupational labels require handlers wear baseline attire (long sleeved shirt, long pants, shoes and socks) and chemical resistant gloves in consideration of potential exposure. Additional PPE is required for some permethrin formulations (e.g., coveralls, NIOSH approved respirators, etc.) and is further detailed in section 8.1 under *Mitigation/Personal Protective Equipment*.

There are registered permethrin product labels for use in residential settings which require specific clothing (e.g., long sleeve shirt/long pants) and/or PPE. Therefore, HED has made the assumption that these products are not for homeowner use, and has not conducted a quantitative residential handler assessment. The uses which have been assessed for residential handlers have been identified in Section 5.1 and Appendix A, Table 4.1 and 4.2.

Permethrin is a RUP due to toxicity to fish and aquatic organisms for all agricultural outdoor broadcast applications including agricultural crops, golf courses, and nurseries. It may not be applied directly to water, or to areas where surface water is present or to intertidal areas below the mean water mark. With the exception of drain/sewer specific label directions; application is prohibited directly into sewers or drains, or to any area like a gutter where drainage to sewers, storm drains, water bodies, or aquatic habitat can occur.

Re-entry restrictions are found on the registered labels for indoor aerosol sprays and foggers which direct applicators to exit treated areas immediately and remain outside the treated area until aerosols and vapors have dispersed. Adults, children and pets should not enter treated areas until sprays have dried or vapors, mist and aerosols have dispersed and rooms are ventilated.

A summary of the representative registered food end-use products and use sites with the highest application rates or percent ai is provided in Appendix A, Table 4.1. A summary of the representative registered non-food/non-crop end use products and use sites with the highest application rates or percent ai is provided in Appendix A, Table 4.2.

5.0 Residential Exposure and Risk Estimates

[3] *Permethrin Final HED Master Label Report 9-29-2010*, the *Summary of Labeling Changes for Permethrin (revised 8/29/2011)* *https://www.regulations.gov/document?D=EPA-HQ-OPP-2004-0385-0128*

There are no newly proposed residential uses at this time; however, there are existing residential uses that have been reassessed in this document to reflect updates to HED's 2012 Residential SOPs[4] along with policy changes for body weight assumptions. The following changes have also been incorporated.

- residential incidental oral post-application exposure risk estimates resulting from vector mosquito control aerial and truck mounted fogger applications have been revised to incorporate the new off-target deposition rate of 8.7 percent of the application rate may be used to evaluate ground-based ULV applications;
- chemical-specific TTR data are available and have been adjusted and reflect the maximum application rates for permethrin; and
- the inhalation and incidental oral scenarios have been reevaluated to incorporate changes to the permethrin toxicity database and to provide a refined assessment of the end-use products.

Residential handler and post-application exposures are anticipated from the registered use of permethrin. In assessing these exposures, HED used the *REJV National Pesticide Use Survey* (2012-2013), which underwent secondary review in 2016[5], to refine the cancer assessment. REJV data are proprietary and, thus, are subject to the data protection provisions of FIFRA. The revision of residential exposures will impact the human health cancer and non-cancer aggregate risk assessments for permethrin.

5.1 Residential Handler Exposure/Risk Estimates

HED uses the term "handlers" to describe those individuals who are involved in the pesticide application process. HED believes that there are distinct tasks related to applications and that exposures can vary depending on the specifics of each task. Residential handlers are addressed somewhat differently by HED as homeowners are assumed to complete all elements of an application without use of any protective equipment.

Several permethrin products require PPE to be worn by applicators. These labels were not considered to be marketed as consumer products and have been considered only for residential post-application exposure assessment as products with PPE requirements are assumed to imply applications are done by professionals. Permethrin product labels with residential use sites that do not require specific clothing (e.g., long sleeve shirt/long pants) and/or personal protective equipment (PPE), have been considered in the residential handler assessment.

Residential handler exposures to permethrin pet products may occur via the dermal or inhalation routes while the product is placed on a cat or dog. In addition, dermal exposures would only be expected from spot-on applications (inhalation exposures are considered negligible in this formulation). Both short-term non-cancer and cancer residential handler exposure assessments were performed for adult homeowners applying permethrin dusts/powders, dips, RTU products, and pump/trigger sprays products to cats and dogs. Since there is no non-cancer dermal hazard

[4] Available: http://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide

[5] Review of "Residential Exposure Joint Venture: National Pesticide Use Survey", M. Crowley *et. al.*, 21-JUL-2016; D433915

for permethrin, the short-term (non-cancer) handler assessment includes only inhalation exposures. For the cancer assessment, both dermal and inhalation exposures are assessed.

The quantitative exposure/risk assessment developed for residential handlers is based on the following scenarios which correlate to the use pattern, Table 4.2 in Appendix A:

- Application to:
    1. Indoor Perimeter/Spot/Bedbug; Crack and Crevice Application with Bulb Duster
    2. Outdoor Garden/Tree (Ornamental) Dust Application with Shaker Can
    3. Indoor Perimeter/ Spot/ Bedbug (course application) with Aerosol Can
    4. Fabric Directed Spray (insect repellent) Spot/Bedbug Application with Aerosol Can
    5. Outdoor Garden/Tree (Ornamental) Application with Aerosol Can
    6. Outdoor Space/Perimeter Treatment with Aerosol Can
    7. Indoor Perimeter/ Spot/ Bedbug (course application) with Trigger-Spray Bottle
    8. Fabric Directed Spray (insect repellent) Spot/Bedbug Application with Trigger-Spray Bottle
    9. Outdoor Garden/Tree (Ornamental) Application with Trigger-Spray Bottle
    10. Outdoor Lawn/Turf Treatment with Hose-end Sprayer
    11. Outdoor Lawn/Turf Treatment with Push-type Rotary Spreader
    12. Outdoor Lawn/Turf Treatment with Belly Grinder
    13. Outdoor Lawn/Turf Treatment with Spoon
    14. Outdoor Lawn/Turf Treatment with Cup
    15. Outdoor Lawn/Turf Treatment Dispersed by Hand
    16. Outdoor Perimeter Treatment with Shaker Can
    17. Outdoor Paints/Preservative Wood Treatment with Airless Sprayer
    18. Outdoor Paints/Preservative Wood Treatment with Brush
    19. Outdoor Paints/Preservative Wood Treatment with Manually-pressurized handwand
    20. Outdoor Paints/Preservative Wood Treatment with Roller
    21. Direct Application to Dogs with Dip Treatment
    22. Direct Body Wipe Application to Dogs/Horses with Sponge/Towelette
    23. Direct Application to Dogs/Horses with Trigger-Spray Bottle
    24. Direct Application to Dogs with Aerosol Can
    25. Direct Application to Dogs with RTU via Hand/Glove
    26. Direct Spot-On Treatment to Dogs with RTU Applicator Tube
    27. Direct Application to Dogs/Horses with Shaker Can
- Mixing/Loading/Applying:
    28. Indoor Perimeter/Spot/ Bedbug (coarse application); Perimeter /Spot/ Bedbug (pinstream application); Crack and Crevice with Manually-pressurized handwand (w/ or w/o pin stream nozzle)
    29. Indoor/Outdoor Garden/Tree/Ornamental Application with Manually-pressurized handwand
    30. Outdoor Garden/Tree/Ornamental Application with Manually-pressurized handwand
    31. Outdoor Lawn/Turf/Perimeter Treatment with Manually-pressurized handwand

32. Outdoor Garden/Tree/Ornamental Application with backpack
33. Indoor/Outdoor Garden/Tree/Ornamental Application with Backpack
34. Outdoor Lawn/Turf/Perimeter Treatment with Backpack

Residential Handler Exposure Data and Assumptions
A series of assumptions and exposure factors served as the basis for completing the residential handler risk assessments. Each assumption and factor is detailed below.

Application Rate:
A screening-level approach was used for assessment of residential exposures by evaluation of the maximum application rate for all possible residential handler exposure scenarios of permethrin. The registered application rates of permethrin quantitative exposure/risk assessment developed for residential handlers is based on the scenarios listed in Appendix A, Tables 4.1 and 4.2.

Unit Exposures and Area Treated or Amount Handled:
Unit exposure values and estimates for area treated or amount handled were taken from HED's 2012 Residential SOPs[6], when available.

For assessment of residential application to horses, it was assumed that 3 horses were treated per day. This recommendation is based upon data available from the American Veterinary Medical Association (AVMA) which references data from its U.S. Pet Ownership and Demographics Sourcebook (2012) that reports pet owners have an average of 2.7 horses per household.[7]

Exposure Duration:
The toxicological profile of pyrethroids characterizes pyrethroids, including permethrin, as being rapid in onset and associated with acute, peak exposures. The single dose and repeat dosing studies show that repeat exposures do not result in lower PODs (i.e. there is no evidence of increasing toxicity with an increased duration of exposure). As such, the totality of the information suggests that only single day (short-term) risk assessments need to be conducted for permethrin. Therefore, residential handler short-term exposure is considered protective of the longer durations since intermediate- and long-term exposure is expected, but due to the nature of this chemical only a short-term assessment is needed.

Residential Handler Non-Cancer Exposure and Risk Estimate Equations
The algorithms used to estimate exposure and dose for residential handlers can be found in Appendix F and the 2012 Residential SOPs[8].

Combining Exposures/Risk Estimates:
Residential handler dermal and inhalation exposure is anticipated from registered permethrin uses, however there is no non-cancer dermal hazard for permethrin. Therefore, only non-cancer

[6] Available: http://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide
[7] https://www.avma.org/KB/Resources/Statistics/Pages/Market-research-statistics-US-pet-ownership.aspx
[8] Available: http://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide

inhalation exposures have been quantitatively assessed and there are no additional routes to combine.

For residential handlers, exposures from application to turf were not combined with exposures from treating gardens/trees because concurrent use of separate pesticide products that contain the same active ingredient to treat the same or different pests does not typically occur. Therefore, although the same products allow treatment of gardens/trees and turf, these exposures were not combined for residential handlers.

Residential Handler Cancer Exposure and Risk Estimate Equations

Cancer risk estimates were calculated using a linear low-dose extrapolation approach in which a Lifetime Average Daily Dose (LADD) is first calculated and then compared with a Q_1* that has been calculated for permethrin based on dose response data in the appropriate toxicology study (Q_1* = 9.567 x 10^{-3} $(mg/kg/day)^{-1}$). Absorbed average daily dose (ADD) levels were used as the basis for calculating the LADD values. Dermal and inhalation ADD values were first added together to obtain combined ADD values. LADD values were then calculated and compared to the Q_1* to obtain cancer risk estimates. While no dermal hazard was identified for the non-cancer quantitative assessment, the Q_1* was used in coordination with the DAF of 3.3% (as detailed in Section 3.0). The algorithms used to estimate the dermal dose, LADD, and cancer risk for residential handlers can be found in Appendix G and Appendix H.

Days per Year of Exposure:
As the days of exposure per year is needed to calculate the LADD and the maximum number of applications/re-treatment intervals provided on the permethrin labels are not considered prescriptive for efficacy, the label-stated number of treatments per year may not be representative of actual usage. Therefore, the maximum days per year of exposure for residential handlers have been refined using data on application frequencies from the Residential Exposure Joint Venture (REJV) National Pesticide Use Survey (2012-2013) which underwent secondary review in 2016[9]. Use site- and method-specific application information specific to permethrin registrations was compiled, however, the data were not subset for permethrin-specific products. The results, as they relate to the permethrin use pattern, are presented as a range in Table 5.1.1, including the average and 95th percentile for the number of applications made per year, as well as the maximum number of applications made per year. The survey search criteria and calculations are summarized in Appendix D, Table D.1. These application frequencies reflect responses for a single year per household (the extent of the survey), not an average of multiple years. Pest pressures and product usage are expected to vary over the course of a lifetime, and consumers are not expected to continuously, year-after-year, apply products at the high frequencies reflected in high percentile and maximum survey results. Therefore, for the purposes of representing the average use of permethrin products over a lifetime by residential handlers for the residential handler cancer assessment, the average data have been used.

[9] Review of "Residential Exposure Joint Venture: National Pesticide Use Survey", M. Crowley *et. al.*, 21-JUL-2016; D433915

Table 5.1.1. Residential Exposure Joint Venture Results for Number of Applications per Year[1]				
Formulation	**Exposure Scenario**	**Average[2]**	**95th percentile[3]**	**Maximum**
Dust	1. Indoor Perimeter/Spot/Bedbug; Crack and Crevice Application with Bulb Duster	3.03	14	30
	2. Outdoor Garden/Tree (Ornamental) Dust Application with Shaker Can	2.99	9	18
	27. Direct Application to Dogs/Horses with Shaker Can	2.05	4	6
RTU	3. Indoor Perimeter/ Spot/ Bedbug (coarse application) with Aerosol Can	6.49	21	259
	4. Fabric Directed Spray (insect repellent) Spot/Bedbug Application with Aerosol Can	2.71	10	39
	5. Outdoor Garden/Tree (Ornamental) Application with Aerosol Can	2.83	9	32
	6. Outdoor Space/Perimeter Treatment with Aerosol Can	2.13	7	10
	7. Indoor Perimeter/ Spot/ Bedbug (course application) with Trigger-Spray Bottle	3.75	11	107
	8. Fabric Directed Spray (insect repellent) Spot/Bedbug Application with Trigger-Spray Bottle	2.71	10	39
	9. Outdoor Garden/Tree (Ornamental) Application with Trigger-Spray Bottle	2.83	9	32
	10. Outdoor Lawn/Turf Treatment with Hose-end Sprayer	2.53	5	65
	23. Direct Application to Dogs/Horses with Trigger-Spray Bottle	6.09	28	170
	24. Direct Application to Dogs with Aerosol Can	3.04	9	24
	25. Direct Application to Dogs with RTU via Hand/Glove	5.11	17	56
	26. Direct Spot-On Treatment to Dogs with RTU Applicator Tube	5.49	15	32
	Other: Indoor Fogger Application	2.02	5	16
	Other: Outdoor Aerosol Space Spray	2.57	6	76
	Other: Pressurized liquid application to Mattress	3.66	20	32
Granular	11. Outdoor Lawn/Turf Treatment with Push-type Rotary Spreader	2.04	5	31
	12. Outdoor Lawn/Turf Treatment with Belly Grinder	1.93	5	14
	13. Outdoor Lawn/Turf Treatment with Spoon	3.67	12	47
	14. Outdoor Lawn/Turf Treatment with Cup	3.67	12	47
	15. Outdoor Lawn/Turf Treatment Dispersed by Hand	3.10	11	34
	16. Outdoor Perimeter Treatment with Shaker Can	3.67	12	47
Paints/ Preservatives/ Stains	17. Outdoor Paints/Preservative Wood Treatment with Airless Sprayer	3.30	10	40
	18. Outdoor Paints/Preservative Wood Treatment with Brush	3.30	10	40
	19. Outdoor Paints/Preservative Wood Treatment with Manually-pressurized handwand	2.79	8	34
	20. Outdoor Paints/Preservative Wood Treatment with Roller	3.30	10	40
Liquid Concentrate	21. Direct Application to Dogs with Dip Treatment	3.10	9	30
	22. Direct Body Wipe Application to Dogs/Horses with Sponge/Towelette	5.52	15	32
	28. Indoor Perimeter/Spot/ Bedbug (course application); Perimeter /Spot/ Bedbug (pinstream application); Crack and Crevice with Manually-pressurized handwand (w/ or w/o pin stream nozzle)	2.12	6	17
	29. Indoor/Outdoor Garden/Tree/Ornamental Application with	3.29	10	48

Table 5.1.1. Residential Exposure Joint Venture Results for Number of Applications per Year[1]				
Formulation	**Exposure Scenario**	**Average[2]**	**95th percentile[3]**	**Maximum**
	Manually-pressurized handwand			
	30. Outdoor Garden/Tree/Ornamental Application with Manually-pressurized handwand	3.29	10	48
	31. Outdoor Lawn/Turf/Perimeter Treatment with Manually-pressurized handwand	2.67	8	23
	32. Outdoor Garden/Tree/Ornamental Application with backpack	2.2	6	7
	33. Indoor/Outdoor Garden/Tree/Ornamental Application with Backpack	2.2	6	7
	34. Outdoor Lawn/Turf/Perimeter Treatment with Backpack	2.53	12	14
	Other: Indoor Barn Misting System	2.61	7	49

1. Program search criteria and calculations are detailed in Appendix D Table D.1.
2. Sampling weighted averages were not used in this assessment.
3. 95th percentile was rounded to the closest number of applications as shown in Appendix D, Table D.1.

Lifetime Expectancy:
Life expectancy values are from the Exposure Factors Handbook 2011 Edition Table 18-1 (U.S. EPA, 2011). The table shows that the overall life expectancy is 78 years based on life expectancy data from 2007. In 2007, the average life expectancy for males was 75 years and 80 years for females. Based on the available data, the recommended value for use in cancer risk assessments is 78 years.

Years per Lifetime of Exposure:
It is assumed that residential handlers would be exposed for 50 years out of a 78-year lifespan.

Summary of Residential Handler Non-Cancer Exposure and Risk Estimates
All registered residential uses were reassessed using the revised 2012 Residential SOPs and policy changes for body weights. All screening-level residential handler non-cancer inhalation risks estimated are not of concern with MOEs ranging from 370 to 770,000 (adult inhalation LOC = 30). The residential handler exposure risk estimates are summarized in Table 5.1.2.

Summary of Residential Handler Cancer Exposure and Risk Estimates
The cancer exposure and risk estimates for permethrin residential handler scenarios are presented in Table 5.1.2. Residential handler cancer (dermal + inhalation) risk estimates range from 3×10^{-10} to 2×10^{-6} with the greatest cancer risk estimate for liquid applications to outdoor gardens/trees/ornamentals with a backpack sprayer.

Table 5.1.2. Residential Handler Non-Cancer and Cancer Exposure and Risk Estimates for Permethrin.											
Formulation	Exposure Scenario	Unit Exposure (mg/lb ai)		Maximum Application Rate[1]	Area Treated or Amount Handled Daily[2]	Non-Cancer		Cancer			
						Inhalation		REJV[6] (apps per year)	Route Specific LADD[8]		Cancer Risk Estimate[9]
		Dermal	Inhalation			Dose (mg/kg/day)[4]	MOE[5]		Inhalation	Dermal[7]	
Applicator											
Dust/Powder	1. Indoor Perimeter/Spot/Bedbug; Crack and Crevice Application with Bulb Duster	250	1.7	0.01 lb ai/lb dust	0.25 lb dust	0.000053	59000	3.03	2.822E-07	1.385E-06	1.59E-08
	2. Outdoor Garden/Tree (Ornamental) Dust Application with Shaker Can	4300	18	0.0025 lb ai/can	2 cans	0.0011	2800	2.99	5.785E-06	4.68E-05	5.03E-07
RTU	3. Indoor Perimeter/ Spot/ Bedbug (course application) with Aerosol Can	370	3.0	0.00438 lb ai/16 oz can	0.5 – 16 oz can (8 oz)	0.000082	38,000	6.46	9.298E-07	3.742E-06	4.47E-08
	4. Fabric Directed Spray (insect repellent) Spot/Bedbug Application with Aerosol Can	N/A	3.0	0.0075 lb ai/can	1 can	0.00028	11,000	3.27	1.61E-06	Negligible	1.54E-08
	5. Outdoor Garden/Tree (Ornamental) Application with Aerosol Can	370	3.0	0.0025 lb ai/can	2 cans	0.00019	17,000	3.19	1.065E-06	4.261E-06	5.10E-08
	6. Outdoor Space/Perimeter Treatment with Aerosol Can	370	3.0	0.225 lb ai/can	1 can	0.0084	370	2.13	3.146E-05	0.0001273	1.52E-06
	7. Indoor Perimeter/ Spot/ Bedbug (course application) with Trigger-Spray Bottle	85.1	0.061	0.043 lb ai/bottle	0.5 bottle	0.000017	190,000	3.75	1.119E-07	5.067E-06	4.96E-08
	8. Fabric Directed Spray (insect repellent) Spot/Bedbug Application with Trigger-Spray Bottle	N/A	0.061	0.0075 lb ai/bottle	1 bottle	0.0000057	550,000	3.27	3.277E-08	Negligible	3.14E-10
	9. Outdoor Garden/Tree (Ornamental) Application with Trigger-Spray Bottle	85.1	0.061	0.043 lb ai/bottle	2 bottles	0.000066	48,000	3.19	3.701E-07	1.682E-05	1.64E-07
	10. Outdoor Lawn/Turf Treatment with Hose-end Sprayer	6.26	0.034	0.45 lb ai/acre	0.5 acres	0.000096	33,000	2.53	4.264E-07	2.576E-06	2.87E-08
Granular	11. Outdoor Lawn/Turf Treatment with Push-type Rotary Spreader	0.81	0.0026	0.65 lb ai/acre	0.5 acres	0.000011	300,000	2.04	3.943E-08	3.943E-07	4.15E-09
	12. Outdoor Lawn/Turf Treatment with Belly Grinder	360	0.039	0.0003125 lb ai/ft^2	1200 ft^2	0.00018	17,000	1.93	6.113E-07	0.0001902	1.83E-06
	13. Outdoor Lawn/Turf Treatment with Spoon	6.2	0.087	0.0003125 lb ai/ft^2	100 ft^2	0.000034	92,000	3.67	2.189E-07	5.152E-07	7.02E-09
	14. Outdoor Lawn/Turf Treatment with Cup	0.11	0.013	0.00156 lb ai/ft^2	100 ft^2	0.000025	120,000	3.67	1.61E-07	4.572E-08	1.98E-09
	15. Outdoor Lawn/Turf Treatment Dispersed by Hand	160	0.38	0.0003125 lb ai/ft^2	100 ft^2	0.00015	21,000	3.10	8.159E-07	1.142E-05	1.17E-07
	16. Outdoor Perimeter Treatment with Shaker Can	0.11	0.013	0.0008 lb ai/ft^2	100 ft^2	0.000013	240,000	3.67	8.371E-08	2.318E-08	1.02E-09
Paints/ Preservatives / Stain	17. Outdoor Paints/Preservative Wood Treatment with Airless Sprayer	160	0.56	0.04 lb ai/gal	5 gal	0.0014	2,200	3.30	8.113E-06	7.533E-05	7.98E-07
	18. Outdoor Paints/Preservative Wood Treatment with	450	0.20	0.04 lb ai/gal	2 gal	0.0002	16,000	3.30	1.159E-06	8.692E-05	8.43E-07

Table 5.1.2. Residential Handler Non-Cancer and Cancer Exposure and Risk Estimates for Permethrin.											
Formulation	Exposure Scenario	Unit Exposure (mg/lb ai)		Maximum Application Rate[1]	Area Treated or Amount Handled Daily[2]	Non-Cancer		Cancer			
						Inhalation		REJV[6] (apps per year)	Route Specific LADD[8]		Cancer Risk Estimate[9]
		Dermal	Inhalation			Dose (mg/kg/day)[4]	MOE[5]		Inhalation	Dermal[7]	
	Brush										
	19. Outdoor Paints/Preservative Wood Treatment with Manually-pressurized handwand	63	0.018	0.04 lb ai/gal	3 gal	0.000027	120,000	2.79	1.323E-07	1.52E-05	1.47E-07
	20. Outdoor Paints/Preservative Wood Treatment with Roller	450	0.20	0.04 lb ai/gal	1 gal	0.0002	16,000	3.30	1.159E-06	8.692E-05	8.43E-07
Liquid Concentrate	21. Direct Application to Dogs with Dip Treatment	100	0.027	0.006 lb ai/gal	2 animals	0.0000041	770,000	3.02	2.174E-08	2.652E-06	2.56E-08
	22. Direct Body Wipe Application to Dogs/Horses with Sponge/Towelette	1600	0.21	0.0062 lb ai/animal	3 horses (protective of 2 dogs)	0.000049	64,000	5.52	4.753E-07	0.0001164	1.12E-06
RTU	23. Direct Application to Dogs/Horses with Trigger-Spray Bottle	820	3.3	0.007 lb ai/animal	3 animals	0.00087	3,600	6.09	9.304E-06	7.593E-05	8.15E-07
	24. Direct Application to Dogs with Aerosol Can	820	3.3	0.000538 lb ai/16 oz can	2 animals	0.000044	70,000	3.04	2.348E-07	1.921E-06	2.06E-08
	25. Direct Application to Dogs with RTU via Hand/Glove	2000	0.29	0.0014 lb ai/animal		0.00001	310,000	5.11	8.976E-09	2.065E-05	1.98E-07
	26. Direct Spot-On Treatment to Dogs with RTU Applicator Tube	120	negligible	0.006 lb ai/animal		Negligible	Negligible	5.49	Negligible	5.691E-06	5.44E-08
Dust	27. Direct Application to Dogs/Horses with Shaker Can	4300	18	0.0625 lb ai/animal	3 animals	0.00011	29,000	2.05	3.956E-07	5.754E-07	9.29E-09
Mixer/Loader/Applicator											
Liquid Concentrates	28. Indoor Perimeter/Spot/ Bedbug (course application); Perimeter /Spot/ Bedbug (pinstream application); Crack and Crevice with Manually-pressurized handwand (w/ or w/o pin stream nozzle)	69	1.1	0.042 lb ai/gal	0.5 gal	0.00029	11,000	2.12	1.078E-06	2.23E-06	3.16E-08
	29. Indoor/Outdoor Garden/Tree/Ornamental Application with Manually-pressurized handwand	63	0.018	0.041 lb ai/gal	5 gal	0.000046	68,000	3.29	2.662E-07	3.067E-05	2.96E-07
	30. Outdoor Garden/Tree/Ornamental Application with Manually-pressurized handwand	63	0.018	0.00078 lb ai/ft^2	1200 ft^2	0.00021	15,000	3.29	1.215E-06	0.0001389	1.34E-06
	31. Outdoor Lawn/Turf/Perimeter Treatment with Manually-pressurized handwand	63	0.018	0.78 lb ai/gal	5 gal	0.000045	69,000	2.67	2.108E-07	2.436E-05	2.35E-07
	32. Outdoor Garden/Tree/Ornamental Application with backpack	130	0.14	0.00078 lb ai/ft^2	1200 ft^2	0.0016	1,900	2.20	6.182E-06	0.0001932	1.91E-06

Table 5.1.2. Residential Handler Non-Cancer and Cancer Exposure and Risk Estimates for Permethrin.											
Formulation	Exposure Scenario	Unit Exposure (mg/lb ai)		Maximum Application Rate[1]	Area Treated or Amount Handled Daily[2]	Non-Cancer		Cancer			
						Inhalation		REJV[6] (apps per year)	Route Specific LADD[8]		Cancer Risk Estimate[9]
		Dermal	Inhalation			Dose (mg/kg/day)[4]	MOE[5]		Inhalation	Dermal[7]	
	33. Indoor/Outdoor Garden/Tree/Ornamental Application with Backpack	130	0.018	0.041 lb ai/gal	5 gal	0.00036	8,700	2.20	1.391E-06	4.25E-05	4.20E-07
	34. Outdoor Lawn/Turf/Perimeter Treatment with Backpack	130	0.14	0.78 lb ai/gal	5 gal	0.0068	8,900	2.53	1.556E-06	4.89E-05	4.83E-07

1 Based on registered labels in Appendix A - Table 4.1 and 4.2
2 Based on HED's 2012 Residential SOPs (http://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide).
4 Inhalation Dose = Inhalation Unit Exposure (mg/lb ai) × Application Rate (lb ai/acre or gal) × Area Treated or Amount Handled (A/day or gallons/day) ÷ BW (80kg).
5 Inhalation MOE = Inhalation NOAEL (mg/kg/day) ÷ Inhalation Dose (mg/kg/day).
6 See Table 5.1.1 for application percentile ranges or Appendix D Table D.1 for REJV search criteria.
7 Dermal Dose = Dermal Unit Exposure (mg/lb ai) × Application Rate (lb ai/acre or gal) × Area Treated or Amount Handled (A/day or gallons/day) ÷ BW (80kg).
8 Route specific LADD = Dermal or Inhalation dose (mg/kg/day) × (REJV days of exposure per year (days/yr) ÷ 365 days/year] × [Years per lifetime of exposure (50 yrs) ÷ Lifetime expectancy (78 yrs)].
9 Cancer risk estimates = Total LADD (Dermal LADD + Inhalation LADD) * Q1*, where Q1* = $9.567\times^{-3}$ (mg/kg/day)-1.

5.2 Residential Post-Application Exposure/Risk Estimates

There is the potential for post-application exposure for individuals exposed as a result of being in an environment that has been previously treated with permethrin. As there is no dermal hazard identified for the non-cancer assessment, there are few adult post-application scenarios where exposure would be anticipated (i.e., no adult dermal or incidental oral exposure assessed). The quantitative non-cancer exposure/risk assessment for residential post-application exposures is based on the following scenarios:

- Children 1 to < 2 years old incidental oral (hand-to-mouth and object-to-mouth) post-application exposures from contact with treated carpet and hard flooring following indoor crack and crevice, total release fogger, and perimeter/spot/bedbug applications;
- Children 1 to < 2 years old incidental oral (hand-to-mouth and object-to-mouth) post-application exposures from contact with treated turf following broadcast application (liquid formulation application rates presented are protective of granular formulation application rates);
- Children 1 to < 2 years old incidental oral (hand-to-mouth) post-application exposures from contact with treated pets;
- Children 1 to < 2 years old incidental oral (hand-to-mouth and object-to-mouth) post-application exposures from contact with outdoor treated wood (paints);
- Children 1 to < 2 years old incidental oral (hand-to-mouth and object-to-mouth) post-application exposures from contact with treated/impregnated fabrics (permethrin specific study value used for fraction transferred)
- Adult inhalation post-application exposures from activities following outdoor residential misting system and barn misting system usage;
- Children 3 to < 6 years old inhalation and incidental oral (hand-to-mouth) post-application exposures from activities outdoors following outdoor residential misting system and barn misting system usage;
- Adult inhalation post-application exposures from activities following public health use ULV mosquito foggers (aerial and truck-mounted);
- Children 1 to < 2 years old inhalation and incidental oral (hand-to-mouth) post-application exposures from activities following public health use ULV mosquito foggers (aerial and truck-mounted).

In addition, the quantitative cancer exposure/risk assessment for residential post-application exposures is based on the following scenarios:

- Adult dermal and inhalation post-application exposures from activities following:
    - Indoor animal barn misting system applications (normal infestation and initial application rates);
    - Outdoor residential misting system applications;
    - Outdoor aerosol space sprays;
    - Public health use ULV mosquito foggers (aerial and truck-mounted);
- Adult dermal only post-application exposures from activities following:
    - Indoor coarse and pin-stream perimeter/spot/bedbug treatments to carpet and hard surfaces;

- Indoor crack and crevice applications to carpets and hard surfaces;
- Fogger applications to carpets and hard surfaces;
- Liquid and granular formulation broadcast applications to turf (high contact lawn activities, mowing,);
- Liquid broadcast applications to golf courses;
- Broadcast applications to gardens/trees;
- Liquid and solid formulation direct applications to dogs and cats (small, medium and large);
- Clothing/fabric treatments (residential and military battle dress uniforms), and;
- Mattress treatments.

Post-application inhalation exposures are not anticipated following surface directed and fogger applications as product labels state a reentry restriction in addition to ventilation of the treated area after use.

The lifestages selected for each post-application scenario are based on an analysis provided as an Appendix in the 2012 Residential SOPs[10]. While not the only lifestage potentially exposed for these post-application scenarios, the lifestage that is included in the quantitative assessment is health protective for the exposures and risk estimates for any other potentially exposed lifestage.

Residential Post-Application Exposure Data and Assumptions

A series of assumptions and exposure factors served as the basis for completing the residential post-application risk assessment. Each assumption and factor is detailed in the 2012 Residential SOPs[10].

Application Rate:

A screening-level approach was used for assessment of residential exposures by evaluation of the maximum application rate for all possible residential post-application exposure scenarios of permethrin. Appendix A, Table 4.1 and Table 4.2 of this document summarize the maximum rates for all registered uses of permethrin.

Exposure Duration:

Residential exposure is expected to be short-term in duration. The single dose and repeat dosing permethrin studies show that repeat exposures do not result in lower points of departure (PODs) (i.e. there is no evidence of increasing toxicity with an increased duration of exposure). Therefore, for purpose of exposure assessments, only single day risk assessments need to be conducted for permethrin, and these are protective of scenarios in which exposure occurs for multiple days.

Residential Post-Application Outdoor TTR Data:

Post-application exposures from golf courses and treated turf were assessed using 0-day residue data from a turf transferable residue study conducted with a liquid permethrin product (MRID 44955501). The chemical-specific TTR data collected with the Modified California Roller

[10] Available: http://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide

Method are available for permethrin, and were summarized in the pyrethroid cumulative assessment[11], and were determined to be acceptable for use in risk assessment. Corrected TTR values have been reassessed to incorporate current regression modeling into this assessment resulting in day-0 TTR of **0.061 µg/cm^2** at the study application rate of 0.87 lbs ai/acre. The TTR Day-0 transfer residue did not require adjustment for liquid applications as the current maximum labeled application rate for permethrin is also 0.87 lb ai/acre. As there is no dermal hazard for a permethrin non-cancer assessment, only incidental oral and accidental ingestion scenarios have been qualitatively assessed for children 1 to <2 years old. Table 5.2.1 summarizes the available pyrethroid TTR data.

Table 5.2.1 Pyrethroid TTR Summary

Chemical (study app rate)	Study	Sites	Day 0 TTR (ug/cm^2)	Average Day 0 TTR (ug/cm^2)	Daily Dissipation (%)
Permethrin (0.87 lbs ai/acre)	Transferable Turf Residue Study: Permethrin Residues in Turf Following Application of Dragnet® SFR Insecticide/Miticide (MRID 44955501)	PA (L)	0.051	0.061	11%
		CA (L)	0.073		
		GA (L)	0.058		

Residential Post-Application Outdoor DFR Data:

For the garden and ornamental use scenario, chemical-specific dislodgeable foliar residue (DFR) data are available for four pyrethroids: cyfluthrin, fluvalinate, esfenvalerate, and permethrin. Most of these DFR data were collected on orchard crops (i.e., stone fruits, apples, oranges) or in greenhouses. The esfenvalerate DFR data summarized in the pyrethroid cumulative document (K.Whitby, D394576, 10/4/2011) included analysis of foliar residues on corn and broccoli and are considered most representative of potential crops that could be found in a home garden. The permethrin DFR data included analysis of foliar residues on peach and are considered most representative of potential crops that could be found on residential fruit and nut trees. Table 6.2.2 summarizes the available pyrethroid DFR data.

Table 5.2.2. Pyrethroid DFR Summary

Chemical	Study	Sites	Day 0 DFR (ug/cm^2)	Average Day 0 DFR (representative of a 0.05 lb ai/A) (ug/cm^2)	Max Label Application Rate	Normalized Average Day 0 DFR[1] (ug/cm^2)
Esfenvalerate	Dissipation of Dislodgeable Foliar Residues of Esfenvalerate from Broccoli Following Application of Asana® XL Insecticide in the USA - Season 1997 (MRID 44852402)	CA1 (L)	0.157	0.132	0.2 lbs ai/acre (0.2 lbs ai/gal)	0.528
		CA2 (L)	0.122			
	Dissipation of Dislodgeable Foliar Residues of Esfenvalerate from Sweet Corn Following Application of	FL (L)	0.072			
		PA (L)	0.177			

[11] *Pyrethrins/Pyrethroid Cumulative Risk Assessment.* M. Crowley *et. al.*; 04-OCT-2003; D394576

Table 5.2.2. Pyrethroid DFR Summary						
Chemical	**Study**	**Sites**	**Day 0 DFR (ug/cm^2)**	**Average Day 0 DFR (representative of a 0.05 lb ai/A) (ug/cm^2)**	**Max Label Application Rate**	**Normalized Average Day 0 DFR[1] (ug/cm^2)**
	Asana® XL Insecticide in the USA - Season 1998 (MRID 44852403)					
Permethrin	"Dissipation of Dislodgeable Foliar Residues of Permethrin Applied to Orchards (Peaches)" (MRID) 437557-01)	CA (Ambush 25W)	0.641	0.87	0.0036 lbs ai/gal 0.4 lbs ai/acre	0.87
		CA (Pounce 3.2)	0.427			
		GA (Ambush 25W)	0.709			
		WA (Ambush 25W)	1.71			

1 Normalized Average Day 0 DFR = Average Day 0 DFR × (Max Label Application Rate ÷ Study Application Rate)

Residential Post-Application Pet (Dog) Dislodgeable Residue Data:
Post-application exposures from spot-on treated beagle dogs were assessed using 0-day residue data from a dislodgeable residue study conducted with a liquid permethrin product (MRID 48135326 and MRID 48135325) which underwent secondary review by HED (A. Rivera-Lupianez, 14-DEC-2010, D380194) after completion of the last assessment in 2009. The test substance, SCH 900560, was administered to 10 beagle dogs by topical application to the skin on the back shoulder blade area using plastic syringes in a spot-on procedure. Permethrin residues were measured on treated dogs after 25 petting simulations, with each simulation consisting of three strokes (75 strokes total). The strokes were conducted using a mannequin hand fitted with two cotton gloves over top of a nitrile glove. Residues were extracted from the nitrile and cotton gloves. Samples were collected from each dog at the following intervals: prior to treatment, at 4, and 8 hours after treatment and at 1, 2, 4, 7, 14, 21, and 28 days after treatment. The cotton and nitrile glove samples were analyzed for permethrin (SCH 169937). The cis and trans isomers of permethrin were analyzed separately and the results summed to provide total permethrin values. Total permethrin average residues from all three gloves combined increased from 9,686 µg/gloves (1.67% of applied dose and 2.98 $\mu g/cm^2$) at 4 hours after application to a maximum of 11,125 µg/gloves (1.93% of applied dose and 3.43 $\mu g/cm^2$) at 8 hours after application. Residues then declined to 821 µg/gloves (0.15% of applied dose and 0.26 $\mu g/cm^2$) by Day 28 after application. This study data was incorporated for both liquid and solid formulations (e.g., spot on, aerosol cans, dusts, etc.).

Based upon HED's review of the permethrin dog residue transfer study, the maximum daily transfer was 1.93 % (8 hours after application) corresponding to a fraction of the application rate available as transferable residue (F_{AR}) value of 0.0193. Using the individual residue data for percentage of applied dose transferable calculations collected from 4 hours through day 28 after application, the daily dissipation was 8.79%.

Post-application Inhalation and Incidental Oral Exposures from Residential Misting Systems:
Residential post-application inhalation exposures are expected for adults and children following treatment with residential misting system. Incidental oral exposures are also expected for children 1 to < 2 years old from contact with permethrin residues that have settled on turf following a pulse, or release, of the misting system. Post-application exposures from residential misting systems are assessed using the methodologies and inputs described in the 2012 Residential SOPs (Outdoor Fogging/Misting Systems SOP). The Outdoor Fogging/Misting Systems SOP recommends input of an active ingredient per single pulse application rate. This single pulse application rate is assumed to occur once hourly during the duration of time the exposed individual spends outdoors, 2.3 hours/day. For permethrin, only a daily maximum application rate (0.25 g/ 1,000 ft^3/day) is provided on product labeling; i.e., the total amount of active ingredient to not be exceeded over the course of all release intervals in a day for all residential automatic misting system products for permethrin. The labels do not provide detail of how many pulses per day should be used to release this total, nor do they describe the time of day that the releases should occur. Typically, residential misting systems are designed so that pulses of active ingredient are released during the time of highest insect activity, during the early morning and late afternoon. In order to determine an active ingredient per pulse release rate appropriate for use with the SOPs, HED has assumed that the label maximum application rate is released over 6 intervals daily; 3 in the early morning and 3 in the early afternoon.
HED has assessed the automated misting system use as though it were intended for residential application and presented the resulting risks which are not of concern (i.e., MOEs range from 1,500 to 86,000).

Residential Post-Application Inhalation and Incidental Oral Exposure from All Surface Directed Indoor Uses (Crack and Crevice/Spot/Bed Bug):
HED has received an Office of Research and Development (ORD) exposure study that was performed in the U.S. EPA's Indoor Air Quality (IAQ) Research House. This study simulated crack and crevice applications of four pesticides; two emulsifiable concentrate products applied via a handheld sprayer (permethrin and cypermethrin), one aerosol can product (propoxur), and one gel bait product (fipronil). The application pattern used in this study is considered a reasonable representation of an indoor crack and crevice application and/or an indoor application for bed bugs. Air concentrations of all four chemicals were collected using stationary air samplers suspended 75 cm above the floor in the room of application (the living room) and two other rooms in the test house (the den and master bedroom). Air samples were collected during the application and 1, 1.5, 2, 2.5, 3, 7, 14, 21, 28, and 35 days after application. Permethrin and cypermethrin air concentrations were not found in any measurable quantities in any room in the research house. Although not all of the data is chemical specific, the Non-Dietary Exposure Task Force (NDETF) has performed an analysis of all the pyrethroid surface deposition and hand press exposure data that they produced. This analysis shows the exposure data for one pyrethroid can generally be used to represent the entire chemical class. Based on this NDETF analysis, HED believes it is appropriate to use the air concentration data from the ORD study as a surrogate for permethrin when applied as described. HED does not have concerns for permethrin for the post-application inhalation exposure scenario given that all air concentration values were below the limit of quantitation in the ORD study.

Post-Application Indoor Fraction of Residue Available for Transfer (Fai): Consistent with the 2011 Pyrethroid CRA, the assessment of indoor post-application exposures uses the average Fai for all pyrethroids. Chemical-specific data provided by the NDETF were used for the fraction of residue available for transfer (Selim, 2004a; Selim, 2003b; Selim, 2003c; Selim, 2000; Selim, 2002b; Selim, 2002c). The NDETF studies examined the transferability of residues from bare hand-presses on carpets and hard surfaces for deltamethrin, permethrin, and pyrethrins. For carpets, the fraction transferred was 0.03, 0.02, and 0.01 for pyrethrins, permethrin and deltamethrin, respectively. For hard surfaces, the fraction transferred was 0.04, 0.03, and 0.05 for pyrethrins, permethrin, and deltamethrin, respectively. Since there is chemical specific data available from these studies, the permethrin fraction transferred was used for this assessment: 0.02 for carpets and 0.03 for hard surfaces. The carpet Fai was also incorporated into the mattress assessment.

Post-Application Impregnated Material/Clothing Exposure:
Post-application exposures to treated fabric were assessed using transfer values from a study determining the transfer of impregnated permethrin products (MRID 4407668-12). Radiolabeled (14C) permethrin-treated fabric patches were applied to the backs of 22 male New Zealand white rabbits in four treatment groups based on environment (temperate vs. subtropical) and fabric type (cotton vs. 50:50 nylon/cotton blend). After seven days, the average percent migration to skin for each treatment group was estimated using the recovery of 14C from excreta and skin. Based on this approach, the overall fraction of a.i transferred per day was **0.005 (0.5%)** and ranged from an average ± standard deviation of 0.004 ± 0.09 fraction a.i. transferred per day in the subtropical/NYCO group to 0.0065 ± 0.10 fraction of a.i. transferred per day in the subtropical/cotton treatment group. For the purposes of this assessment, the 0.5% permethrin transferred per day was incorporated into the non-cancer incidental oral, and cancer dermal assessment. Additional information is available in the 2012 Residential SOPs.

Residential Post-Application Indoor Inhalation Exposure from Fogger Applications:
Post-application inhalation exposure to the use of indoor foggers is expected to be negligible since most fogger product labels typically state a period of no-entry following application (usually up to 4 hours), as well as a ventilation period before occupants can return. Permethrin residential fogger products include a 4-hour period of no entry following application. In addition, due to the low vapor pressure of pyrethroids in general, and the available air concentration data collected from the ORD test house following indoor applications of pyrethroids (D390098), HED does not have concerns for inhalation exposure following indoor fogger applications of permethrin.

Residential Post-Application Indoor Deposited Residue (DepR) Values:
Based on pyrethroid-specific data available in the 2012 SOPs, the following approaches/default values should be used. Note that it is not recommended to pull individual chemical-specific data from the SOPs, but rather to use the collective pyrethroid data available.

- Perimeter/Spot/Bedbug applications (coarse): For coarse perimeter/spot/bedbug applications, the default deposited residue value, **2.6 µg/cm^2**, was used with no adjustment for percent ai. This value is a combination of the pyrethroid data from Keenan (2007) and esfenvalerate data from Selim (2008) for all pyrethroids.

- Perimeter/Spot/Bedbug applications (pin stream): For pin stream perimeter/spot/bedbug applications, the default deposited residue, **1.5 µg/cm^2**, was used with no adjustment for percent ai. This value is a combination of the pyrethroid data from Keenan (2007) and the ORD Test house date (D390098) for all pyrethroids

- Crack and crevice applications: For crack and crevice applications, the default deposited residue value, **0.4 µg/cm^2**, was used with no adjustment for percent ai. This value is a combination of the pyrethroid data from Keenan (2007), the esfenvalerate data from Selim (2008) and the ORD Test house date (D390098) for all pyrethroids.

- Fogger applications: Data from the Non-Dietary Exposure Task Force (NDETF) were used to estimate deposited residue for the pyrethroids with registered indoor fogger uses (Rogers, 2000; Selim, 2002a; Selim, 2003a). The NDETF conducted three studies measuring the deposited residue following application of a 0.2% deltamethrin fogger, a 0.5% permethrin fogger, and a 0.5% pyrethrins fogger. In each study, the fogger was discharged in an experimental room and the resulting deposited residues were measured using deposition coupons. The average residue value (adjusted to 0.5% active ingredient, if necessary) from each study was 5.6 µg/cm^2 for deltamethrin, 4.8 µg/cm^2 for permethrin, and 5.8 µg/cm^2 for pyrethrins. As permethrin specific data is available, the deposition rate of **4.8 µg/cm^2** has been used in this assessment.

Dermal, Inhalation, and incidental oral (children 1-2 years only) Post-application Exposure Resulting from Horse End-use Products:
Based on current policy, post-application child dermal, inhalation, and incidental oral (children 1 to < 2 years only) exposure is not quantitatively assessed for horses. Exposure is expected to be minimal because of the frequency of exposure is intermittent, and direct contact with the treated animal is limited.

Mosquito Adulticide Use:
The post-application exposure potential from public health mosquito adulticide applications has been considered for ground-based truck foggers, backpack ULV foggers, and aerial applications. Chemical-specific exposure data have been submitted to support the permethrin mosquito adulticide use. Therefore, to assess the mosquito adulticide use, the algorithms and inputs presented in the 2012 Residential SOPs, Lawns/Turf section were used coupled with the permethrin TTR data described above. The deposition of permethrin from these applications are not based on the application rate alone, but also using the AgDISP (v8.2.6) model or empirical data to determine how much pesticide is deposited on residential lawns as a result of mosquito adulticide treatments at the maximum application rates for each. The TTR data are then used to determine the fraction of the total residue deposited following the mosquitocide application which can result in exposures to impacted individuals. Inhalation exposures are estimated using AgDISP (v8.2.6) for aerial applications, and a recently developed, Well Mixed Box (WMB) Model approach based on the Residential SOPs for outdoor foggers.

Ground-based Truck-Mounted-Foggers

In an analysis from 2013 (C. Peck, D407817, 3/28/2013), the Environmental Fate and Effects Division (EFED) reviewed eight published studies on ground ULV application in which deposition was measured. The studies varied in collection media (i.e., grass clippings and coupons), distance from application or spray head (ranging from 8 meters to 500 meters), and chemical measured (i.e., fenthion, malathion, naled, and permethrin). After considering the available data, HED has determined that an off-target deposition rate of 8.7 percent of the application rate may be used by HED to evaluate ground-based ULV applications (i.e., 8.7 percent of the target application rate deposits on turf). This value is the 90 percent upper confidence limit on the mean and is slightly higher than the mean values from all the data points observed in the studies (7.1%, n= 94). The adjusted application rate was then used to define TTR levels by scaling the available TTR data as appropriate. As chemical-specific TTR data are available for permethrin, its data was adjusted to reflect the maximum application rates (0.007 lb ai/A) for public health uses of permethrin. The adjusted TTR for permethrin is 4.9E-06 µg/cm^2.

In order to calculate airborne concentrations from ULV truck fogger applications, HED used the 2012 Residential SOPs for Outdoor Fogging/Misting Systems, with minimal modification to the WMB model. The WMB model allows for the estimation of air concentrations in the breathing zones of adults and children for use in calculating the post-application inhalation exposure to individuals residing in areas being treated by ground application of permethrin. For both adults and children, the exposure duration was adjusted to 6 hours as opposed to a default of 1.5 hours to mimic an exposure duration consistent with the 6-hour animal inhalation toxicity study used to define the endpoint and POD used as the basis of this assessment. The methodology more accurately accounts for dilution using the WMB model. The WMB model input parameters and the algorithms used to estimate residential post-application exposures can be found in Appendix F.

Aerial Applications

Deposition and airborne concentrations from aerial ULV applications, was modeled using the AGDISP (version 8.26) model to predict the motion of spray material released from aircraft, and determines the amount of application volume that remained aloft and the amount of the resulting droplets deposited on the surfaces in the treatment area as well as downwind from the treatment area. The 1-hour air concentration was calculated for a height of 5 feet resulting in an average air concentration of 0.0014 mg/ m^3. The deposition fraction provided by *AGDISP* for permethrin was 0.85. The deposition fraction was then used to define TTR levels by scaling the available chemical specific TTR data as appropriate. A summary of data and calculations is available in Appendix B, Figures 5.2.1, and 5.2.2, and 5.2.3 presenting the estimated aerial permethrin residue fraction deposited on turf, an estimation of how permethrin deposition fluctuates over the spray block, and air born concentrations for the 1 hour following mosquito adulticide applications, respectively.

The model also allows for the estimation of air concentrations in the breathing zones of adults and children for use in calculating the post-application inhalation risks to individuals residing in areas being treated by aerial application of permethrin. Post-application inhalation estimates resulting from aerial applications have been revised to incorporate the new HEC which is based on a 4-hour exposure duration.

Post-application Inhalation Exposure resulting from Outdoor Aerosol Space Spray:
In accordance with guidance for outdoor aerosol space sprays (OASS) in the Outdoor Fogging/Misting System Residential SOP, post-application exposure can result from activities performed following outdoor aerosol space spray pesticide applications. However, the SOP indicates that aerosolized pesticide exposure time is not a significant factor for calculation of inhalation exposure from outdoor aerosol space sprays due to the rapid dissipation of pesticide air concentrations. Based on the minimum airflow rate, the pesticide air concentration within the enclosed space (i.e., WMB) is virtually 0 after approximately 7 minutes. Therefore, since permethrin space sprays restrict entry until sprays have settled, which is protective of the air concentration after 7 minutes, a quantitative post-application inhalation exposure assessment is not required.

Indoor Aerosol Space Spray Post-Application Inhalation Exposure:
In accordance with Indoor Residential SOP, a quantitative post-application inhalation exposure assessment is not required for aerosol space sprays if the label has a reentry restriction/ ventilation requirement. Furthermore, the Summary of Labeling Changes for Permethrin (Revised 8/29/2011) requires all space spray labels to state, "do not enter or allow others to enter until vapors, mists, and aerosols have dispersed, and the treated area has been thoroughly ventilated".

Section 18 Military Aircraft Space Spray Residential Exposure:
Residential handler exposure is not anticipated for the registered use. Based on HED's Residential SOPs[12], for typical residential aerosol space sprays, it is assumed that there may be post-application dermal and incidental oral exposure to residues deposited on surfaces, and post-application inhalation exposure to pesticide aerosols that are still airborne after application. However, HED considers these exposures unlikely for the emergency exemption use for the reasons provided below:

- A quantitative non-cancer dermal assessment is unnecessary since a dermal hazard has not been identified. Non-occupational inhalation exposure to aerosolized permethrin by the passengers is not expected as the aerosol spray is applied pre-flight – pre-embarkation (before the passengers/crew board the aircraft).
- The use directions indicate the product is allowed to dry for at least 1 hour, during which the aircraft is closed for 30 minutes after application, and then the aircraft exterior doors, to include cargo doors, are opened and the aircraft is allowed to passively ventilate for a minimum of 30 additional minutes prior to passengers and crew boarding the aircraft.
- Passengers and crew generally consist of adults over the age of 18, but in rare circumstances, children may travel with families via 'space available' seating in military aircrafts. All passengers remain secured in their seats once they have boarded and while the aircraft is in transit, making incidental oral exposure unlikely for children.

Due to the limited mobility of residential passengers, negligible volatilization, permethrin's lack of a dermal toxicological endpoint and low dermal penetration, HED considers residential post-application inhalation, incidental oral, and dermal exposure unlikely. Therefore, a quantitative residential post-application assessment is not necessary for non-cancer or cancer assessments.

[12] Available: http://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide

Dietary exposure is not expected as the label specifies not directly spraying food areas, and neither food or beverage services are provided on military aircraft.

Residential Post-Application Non-Cancer Exposure and Risk Equations
The algorithms used to estimate residential post-application exposure and dose can be found in Appendix F and the 2012 Residential SOPs[13].

Combining Exposure and Risk Estimates
Residential post-application exposures are anticipated via the dermal, inhalation, and incidental oral route for permethrin. There is no dermal hazard for permethrin, so a quantitative non-cancer dermal assessment has not been conducted. Since the remaining exposure routes do share common neurologic toxicological effects (decreased motor activity, body tremors, and hypersensitivity to noise) risk estimates have been combined for those routes. The incidental oral scenarios (i.e., hand-to-mouth and object-to-mouth) should be considered inter-related and it is likely that they occur interspersed amongst each other across time. Combining these scenarios would be overly-conservative because of the conservative nature of each individual assessment.

The post-application exposure scenarios, hand-to-mouth and inhalation exposures, for children 1 to < 2 years old and 3 to <6 years old were combined for each lifestage. This combination should be considered a protective estimate of children's exposure. In order to combine these exposure, an ARI was used since the LOCs for children's hand-to-mouth exposure (300) and inhalation exposure (100) are different. The target ARI is 1; therefore, ARIs of less than 1 are risk estimates of concern. The ARI was calculated as follows.

Aggregate Risk Index (ARI) = 1÷ [(Incidental Oral LOC ÷ Incidental Oral MOE) + (Inhalation LOC ÷ Inhalation MOE)]

Summary of Residential Post-Application Non-Cancer Exposure and Risk Estimates
The majority of screening level residential post-application risks are not of concern and resulted in MOEs greater than their respective LOCs (adult inhalation MOE ≥ 30; child incidental oral MOE ≥ 300; and child inhalation MOE ≥ 100). Children's inhalation + incidental oral exposure following treatment with the higher "initial treatment" application rate (0.50 oz/1,000ft^3/day) for barn misting systems is of concern with an ARI of 0.54 (driven by the inhalation MOE of 54). Normal infestation applications for barn misting systems however are not of concern (0.25 oz/1,000ft^3/day).

A summary of the residential post-application exposure risk estimates which represent the existing residential uses with the highest application rates or percent ai is provided in Table 5.2.

Table 5.2. Residential Post-Application Non-Cancer Exposure and Risk Estimates for Permethrin.

Lifestage	Post-application Exposure Scenario		Application Rate[1]	Dose (mg/kg/day)[2]	MOEs[3]	Combined Risk
	Use Site	Route of Exposure				ARI[4]
Children 1 to < 2	Indoor Perimeter/Spot/Bedbug Application (Coarse) - Carpet	Hand-to-Mouth	0.50%	0.0051	8,600	NA
		Object-to-Mouth		0.0012	37,000	

[13] http://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide

Table 5.2. Residential Post-Application Non-Cancer Exposure and Risk Estimates for Permethrin.						
Lifestage	**Post-application Exposure Scenario**		**Application Rate[1]**	**Dose (mg/kg/day)[2]**	**MOEs[3]**	**Combined Risk**
	Use Site	**Route of Exposure**				**ARI[4]**
Years Old	Indoor Perimeter/Spot/Bedbug Application (Coarse) - Hard Flooring	Hand-to-Mouth		0.0019	23,000	
		Object-to-Mouth		0.0009	50,000	
	Indoor Perimeter/Spot/Bedbug (Pin Stream) Application - Carpet	Hand-to-Mouth		0.0029	15,000	
		Object-to-Mouth		0.0003	150,000	
	Indoor Perimeter/Spot/Bedbug (Pin Stream) Application - Hard Flooring	Hand-to-Mouth		0.0011	40,000	
		Object-to-Mouth		0.0002	200,000	
	Indoor Crack and Crevice - Carpet	Hand-to-Mouth		0.00079	56,000	
		Object-to-Mouth		0.0001	560,000	
	Indoor Crack and Crevice - Hard Flooring	Hand-to-Mouth		0.00029	150,000	
		Object-to-Mouth		0.0001	750,000	
	Indoor Fogger - Carpet	Hand-to-Mouth	0.58%	0.012	3,600	
		Object-to-Mouth		0.0016	27,000	
	Indoor Fogger – Hard Flooring	Hand-to-Mouth		0.0046	9,500	
		Object-to-Mouth		0.0012	36,000	
	Lawn / Turf	Hand-to-Mouth	0.87 lb ai/A [0.04 lb ai/gal] Liquid formulations	0.0084	5,300	NA
		Object-to-Mouth		0.00025	170,000	
		Soil Ingestion		0.000026	1,700,000	
		Granule Ingestion	0.65 lb ai/A [5% permethrin]	0.14	320	
	Contact with Treated Pets	Hand-to-Mouth (liquid formulations i.e, pour-on, trigger spray bottle)	3.18 g ai/ small dog[5] (0.007 lb ai/animal)	0.027	1,600	NA
			3.18 g ai/ small cat[5] (0.007 lb ai/animal)	0.052	840	
		Hand-to-Mouth (solid formulations i.e., dust)	0.0013 oz ai/ small dog (< 20 lbs)	0.073	600	
			0.0025 oz ai/ medium dog > 20 lbs	0.062	700	
			0.0013 oz ai/ small cat[5] (all cats assumed < 20 lbs)	0.15	300	
	Outdoor treated paints	Hand-to-Mouth	0.081 mg ai/cm^2 (7.21 lb ai/A)	0.11	410	NA
	Impregnated Fabric – Custom (Military BDU Study)	Hand-to-Mouth	0.125 mg ai/cm^2	0.017	2,600	
		Object-to-Mouth		0.0082	5,400	
Adult	Outdoor Residential Misting System	Inhalation	0.25 g/ 1,000 ft^3 / day (0.0088 oz ai/ 1,000 ft^3 per day)	0.004	5,800	NA
Children 1 to < 2 Years Old				0.014	1,500	14.25
		Hand-to-Mouth		0.0031	86,000	
Adult	Outdoor Aerosol Space Spray	Inhalation	0.007 lb ai/A (0.225% ai/16 oz can)	0.0015	2,400	NA
Children 1 to < 2 Years Old				0.0057	630	5.44
		Hand-to-Mouth		0.0038	12,000	
Adult	Indoor Animal Barn Misting System	Inhalation	Initial application 0.50 oz/ 1,000 ft^3 / day	0.042	75	NA
Children 3 to < 6 Years Old				**0.058**	**54**	**0.54**
		Hand-to-Mouth		0.0020	22,000	
Adult		Inhalation	Normal infestation 0.25 oz/ 1,000 ft^3 / day	0.021	150	NA
Children 3 to < 6 Years Old				0.029	110	1.09
		Hand-to-Mouth		0.0010	43,000	
Adult	Public Health Use Truck Mounted ULV Mosquito Fogger	Inhalation	0.007 lb ai/A	N/A (0.00090 mg/m^3)	150,000	NA
Children 1 to < 2 Years Old					150,000	1,490
		Hand-to-Mouth		0.00000067	66,000,000	
Adult	Public Health Use Aerial ULV Mosquito Fogger	Inhalation		NA (0.0014 mg/m^3)	94,000	NA
Children 1 to < 2 Years Old					94,000	902
		Hand-to-Mouth		0.0000066	6,700,000	

1 Based on registered labels presented in Appendix A, Table 4.1.
2 Dose (mg/kg/day) algorithms provided in 2012 Residential SOPs (http://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide).
3 MOE = POD (mg/kg/day) ÷ Dose (mg/kg/day).
4 Aggregate Risk Index (ARI) = 1÷ [(Hand-to-Mouth LOC (300) ÷ Hand-to-Mouth MOE) + (Inhalation LOC (100) ÷ Inhalation MOE)], where applicable.
5 The same application rate was used regardless of animal size (small, medium, or large). The small dog/cat is presented since this size results in the greatest risk potential.

Residential Post-Application Cancer Exposure and Risk Estimate Equations

Post-application cancer risk estimates for adults were calculated using a linear low-dose extrapolation approach in which a LADD is first calculated and then compared with a Q_1* that has been calculated for permethrin based on dose response data in the appropriate toxicology study (Q_1* = 9.567 x 10^{-3} $(mg/kg/day)^{-1}$). The algorithms used to estimate the LADD and cancer risk for residential post-application exposure can be found in Appendix H. Some of the inputs for the post-application cancer calculations may be different from the handler cancer calculations and are detailed below.

Cancer Specific Residential Post-Application Exposure Data and Assumptions

REJV National Survey Data
The 2012-2013 REJV survey was used to provide the most recent dataset to determine the typical number of times per year that permethrin broadcast indoor applications are used. The REJV survey is a 12 month long longitudinal survey that examined pesticide use in a residential environment. The data evaluated by HED in this analysis were collected in 2012 to 2013. A detailed summary of the search criteria and results are presented in Appendix D, Table D.1.

Deposited Residues & Dermal Dose Estimates
To determine the average dermal dose over the course of a year, HED combined the starting permethrin depositions (deposited residues) identified for each scenario in Table 5.2.2 and input a daily dissipation each day until the next application took place. The following assumptions were incorporated into the assessment:

- Chemical/pyrethroid specific TTR and DFR dissipation (i.e., 11%) rates were used for relevant outdoor scenarios.
- A 8.79% dissipation rate per day was used for pet scenarios as detailed in the non-cancer assumptions above (A. Rivera-Lupianez, 14-DEC-2010, D380194). For most indoor and outdoor uses, a typical re-treatment interval (RTI) of 30 days was assumed to represent one treatment per month. RTIs of 1 and 7 days were also considered, however, the deposited residue estimates were found to be within relatively similar to the 30 day RTI deposited residue estimate. Some RTIs (e.g., outdoor residential misting systems = 3 day RTI) used shorter intervals as directed by representative labels and REJV data was not appropriate for the use scenario.
- Currently, HED has no chemical specific indoor dissipation data, therefore, for this draft approach HED is conservatively assuming a 10% dissipation rate per day (this value was determined via assumptions from the RED in addition to a rounded average dissipation rate from DFR/TTR/pet dissipation rates).
- A dermal absorption factor of 3.3% was used to determine all dermal cancer estimates assessed.

To represent longer-term exposure to permethrin in indoor environments, the assessment incorporated levels of permethrin in house dust from a study entitled, "Children's Total Exposure to Persistent Pesticides and Other Persistent Organic Pollutants (CTEPP)"[14]. This study was performed by the EPA's office of Research and Development and it was designed to determine what commonly used chemicals are found in home and/or day care environments. A total of 129 dust samples were collected in OH and NC homes and 100% of these samples contained some level of permethrin. For this assessment, HED also assumed that an individual could be exposed to permethrin found in house dust (from the CTEPP study) the remaining days of the year after estimated dissipation (10% per day) reduces the initial concentration equal to or below the dust study value of 0.001283 µg/cm^2 (samples labeled as, "home children at home" were used). To calculate the average daily permethrin exposure value, the surface residues were averaged over the course of 365 days. An example of the calculated yearly average deposited residue is presented in Appendix D, Table D.2. As a result of these considerations, the average deposited residue and dermal LADD equation was updated and calculated as follows:

Yearly Average deposited residue (mg/kg/day) = (∑ Day-0 deposited residue to Day 365 deposited residue) ÷ 365

when

Day X deposited residue = previous days deposited residue × e^ [-(daily dissipation rate) × number of days since most recent application]

*Dermal LADD = **Yearly Average** dermal dose (mg/kg/day) × [days of post-app exposure (365 days) ÷ days in a year (365)] × [years of exposure (50 years) ÷ average lifespan (78 years)]*

Days Per Year of Exposure (Inhalation):
Some formulations (e.g., automatic misting systems and public health uses) are automatically released following pre-programed settings or conducted by local government for insect control and intended to remain suspended in the air for efficacy purposes. However, as previously detailed in the non-cancer portion of the assessment, residues are expected to settle within 7 minutes of the application and volatilization is not expected to occur. Therefore, the days of post-application exposure are limited to the number of applications made per year (as identified by REJV survey data, the use pattern table, submitted data, or representative labels). Scenarios in which post application inhalation exposure is expected to occur, the number of days exposed is detailed below:

- Indoor animal barn misting systems: 3 days or applications (REJV)
- Outdoor residential misting systems: 25 days or applications (EPA Reg. No. 73748-1)
- Outdoor aerosol space spray: 3 days or applications (REJV)
- For public health uses, 8 days of peak deposition exposure was expected (i.e., 1 application every other week) in summer over the course of 4 months.

[14] Morgan, M.K., Sheldon, L.S., Croghan, C.W., 2004. A Pilot Study of Children's Total Exposure to Persistent Pesticides and other Persistent Organic Pollutants (CTEPP). EPA/600/R-041/193, vol. I: Final Report. US Environmental Protection Agency, Research Triangle Park, NC.

Days Per Year of Exposure (Dermal):

- High contact activities on carpet and hard surfaces following indoor applications (including barns): 365 days per year was assumed when considering an averaged typical dose using REJV survey data (assuming 1 REJV application per 7 days).
- High contact lawn activities and public health uses: 120 days (4 months of exposure during warm weather/summer).
- Mowing Turf: 17 days (assuming that mowing takes place once per week over 120 days during warm weather/summer).
- Golfing activities: 52 days (assuming 1 game per week with 52 total exposures over 365 days).
- Gardening and fruit and nut tree activities following outdoor applications: 120 days per year (4 months of exposure during warm weather/summer).
- Pet Treatments: 180 days per year when considering an averaged typical dose using REJV survey data.
- Personal Clothing: 30 days per year when considering an averaged typical dose using REJV survey data.
- Military Clothing: 250 days per year (work days in one year).
- Mattresses: 365 days per year when considering an averaged typical dose using REJV survey data.

For exposure scenarios with multiple sets of applicable average REJV applications, the scenario with the greatest number of applications, rounded to the nearest whole number, was used to calculate the deposited residue. For example, 6 total applications per year was used to calculate post-application exposure to pets (i.e., dust applications to dogs/horses (2.05 applications/year) < direct application to dogs/horses with trigger-spray bottle (6.09 applications/year))

Years Per Lifetime of Exposure:
It is assumed that adults would be exposed for 50 years out of a 78-year lifespan.

Summary of Residential Post-Application Cancer Exposure and Risk Estimates

Indoor Permethrin Exposure: Estimated adult post-application cancer risk estimates range from 3.8×10^{-8} to 3.1×10^{-6}, with the highest cancer risk estimate resulting from indoor animal barn misting system applications (initial application rate).

Outdoor Permethrin Exposure: Estimated adult post-application cancer risk estimates range from 9.1×10^{-9} to 1.2×10^{-6}, with this highest cancer risk estimate resulting from high contact lawn activities treated with granular formulations.

Treated Pet Permethrin Exposure: Estimated adult post-application cancer risk estimates range from 3.3×10^{-6} to 4.0×10^{-5} with the highest cancer risk estimate resulting from contact with small cats treated with liquid formulations.

Treated Fabric/Clothing Permethrin Exposure: Estimated adult post-application cancer risk estimates range from 6.7×10^{-6} to 4.9×10^{-7} with the highest cancer risk estimate resulting from contact with treated mattresses.

Adult residential post-application dermal cancer risk estimates are presented in Table 5.2.2 below.

Table 5.2.2. Residential Post-Application Cancer Exposure and Risk Estimates for Permethrin.								
Adult Post-Application Exposure Scenario		**Route of Exposure**	**Application Rate**	**Days of Exposure per Year**	**Typical Deposited Residue / Exposure[1,2] (ug/cm^2)**	**Absorbed Daily Dose mg/kg/day**	**LADD[3] (mg/kg/day)**	**Cancer Risk Estimate[4]**
Indoors								
Indoor Animal Barn Misting Systems	Normal Infestation	Dermal	0.25%	120	0.10	3.3E-05	2.10E-05	1.26E-06
		Inhalation		3	2.61 mg/m^3	0.042	1.10E-04	
	Initial Application	Dermal	0.50%	120	0.12	1.7E-04	1.05E-04	3.13E-06
		Inhalation		3	5.22 mg/m^3	0.021	2.20E-04	
Perimeter/Spot/Bedbug Treatment (course)	Carpet – high contact activities	Dermal	0.50%	365	0.32	1.4E-04	9.13E-05	8.74E-07
	Hard Surface – high contact activities					5.3E-05	3.43E-05	3.28E-07
Perimeter/Spot/Bedbug Treatment (Pin Stream)	Carpet – high contact activities	Dermal	0.50%		0.089	4.0E-05	2.58E-05	2.46E-07
	Hard Surface – high contact activities					1.5E-05	9.66E-06	9.24E-08
Crack and Crevice	Carpet – high contact activities	Dermal	0.50%		0.04	1.7E-05	1.06E-05	1.02E-07
	Hard Surface – high contact activities					6.2E-06	3.99E-06	3.81E-08
Fogger	Carpet – high contact activities	Dermal	0.50%		0.28	1.3E-04	8.19E-05	7.83E-07
	Hard Surface – high contact activities					4.8E-05	3.07E-05	2.94E-07
Outdoors								
Outdoor residential misting system		Dermal	0.25 g ai/1000 ft^3/day	120	6.8E-07 lb ai/ft^2	3.7E-04	7.85E-05	1.01E-06
		Inhalation		25	1.53 mg/m^3	6.2E-04	2.71E-05	
Outdoor aerosol space spray		Dermal	0.225% ai/16 oz can	120	4.45E-7	2.4E-04	5.11E-05	5.65E-07
		Inhalation		3	0.12 mg/day	0.0015	7.97E-06	
Public health use – Truck Mounted ULV Fogger		Dermal	0.007 lbs ai/A	120	1.00E-06	1.12E-07	2.4E-08	6.04E-09
		Inhalation		8	29.18 mg/day	4.32E-05	6.1E-07	
Public health use – Aerial ULV Mosquito Fogger		Dermal	0.007 lbs ai/A	120	1.3E-04	9.50E-06	2.0E-06	2.14E-08
		Inhalation		8	0.0014 mg/m^3	1.68E-05	2.36E-07	
High Contact Lawn Activities - Liquid		Dermal	0.87 lbs ai/A	120	0.0048	5.4E-04	1.13E-04	1.08E-06
High Contact Lawn Activities - Granular			0.65 lbs ai/A	120		6.0E-04	1.25E-04	1.20E-06
Mowing Turf – Liquid			0.87 lbs ai/A	17		1.1E-05	3.27E-07	3.13E-09
Mowing Turf – Granular			0.65 lbs ai/A	17		1.1E-05	3.26E-07	3.12E-09
Golfing (Liquid Only)			0.79 lbs ai/A	52	0.0044	3.8E-05	3.50E-06	3.35E-08
Gardening Activities (Esfenvalorate DFR data)			0.0036 lbs ai/gal	120	0.045	3.5E-04	7.26E-05	6.95E-07
Fruit and Nut Trees (Permethrin Peach DFR data)			0.2 lbs ai/gal	120	0.074	5.2E-05	1.10E-05	1.05E-07
Pets								
Dog (liquids)	small	Dermal	0.007 lbs ai/animal (3175 mg ai/animal)	180	0.0040 mg/cm^2	6.64E-03	0.00210	2.01E-05
	medium				0.0017 mg/cm^2	2.85E-03	0.00090	8.61E-06
	large				0.0011 mg/cm^2	1.81E-03	0.00057	5.48E-06
Cats (liquids)	small			180	0.0080 mg/cm^2	1.33E-02	0.00420	4.02E-05
	medium				0.0048 mg/cm^2	7.97E-03	0.00252	2.41E-05

Table 5.2.2. Residential Post-Application Cancer Exposure and Risk Estimates for Permethrin.								
Adult Post-Application Exposure Scenario		**Route of Exposure**	**Application Rate**	**Days of Exposure per Year**	**Typical Deposited Residue / Exposure[1,2] (ug/cm²)**	**Absorbed Daily Dose mg/kg/day**	**LADD[3] (mg/kg/day)**	**Cancer Risk Estimate[4]**
	large				0.0030 mg/cm²	4.98E-03	0.00157	1.51E-05
Dog (solids)	small (< 20 lbs rate)		35.4 mg ai/animal	180	0.000045 mg/cm²	1.99E-03	0.00063	6.02E-06
	medium (> 20 lbs rate)		70.85 mg ai/animal		0.000038 mg/cm²	1.71E-03	0.00054	5.16E-06
	large (> 20 lbs rate)				0.000024 mg/cm²	1.09E-03	0.00034	3.28E-06
Cats (solids)	small (< 20 lbs rate)		35.4 mg ai/animal	180	0.00009 mg/cm²	3.98E-03	0.00126	1.20E-05
	medium (< 20 lbs rate)				0.000054 mg/cm²	2.39E-03	0.00076	7.23E-06
	large (< 20 lbs rate)				0.000034 mg/cm²	1.49E-03	0.00047	4.52E-06
Fabric/Clothing								
Clothing	Military Battle Dress Uniform	Dermal	0.125 mg ai/cm²	250	0.0047 mg/cm²	1.1E-04	4.75E-05	4.54E-07
Clothing	Jacket/pants/shirt			30	0.012 mg/cm²	1.3E-04	7.04E-06	6.74E-08
Bedding/Mattresses			15 µg/cm²	365	1.74	8.02E-05	5.13E-05	4.91E-07

1 REJV program search criteria and calculations are detailed in Appendix D, Table D.1.
2 Example of calculated yearly average residue calculations are detailed in Appendix D, Table D.2
3 LADD (mg/kg/day) = Average (dermal or inhalation) dose (mg/kg/day) × [days of post-app exposure (days) ÷ 365 days/year] × [Years per lifetime of exposure (50 yrs) ÷ Lifetime expectancy (78 yrs)].
3 Cancer risk estimates = Total LADD × Q_1^*, where $Q_1^* = 9.567 \times 10^{-3}$ $(mg/kg/day)^{-1}$.

5.3 Residential Risk Estimates for Use in Aggregate Assessment

Non-Cancer Aggregate Assessment:

Table 5.3.1 reflects the residential risk estimates that are recommended for use in the aggregate assessment for permethrin. **The exposure scenario for the higher "initial application" rate from barn misting systems results in risks of concern for children 3 to < 6 years old and, therefore, would not result in an acceptable aggregate risk finding for permethrin. However, if label language issues relating to the barn automated misting system use are addressed, and it is determined that these systems are not intended for residential usage, the following residential risk estimates would then be recommended for aggregate assessment of permethrin:**

- The recommended residential exposure for use in the adult aggregate assessment is from the post-application exposure following indoor barn misting system applications.
- The recommended residential exposure for use in the children 3<6 years old aggregate assessment is for inhalation and hand-to-mouth exposures from post-application exposure following indoor barn misting system applications at the normal infestation rate.
- The recommended residential exposure for use in the children 1<2 years old aggregate assessment is exposure following incidental oral hand to mouth exposure to small cats previously treated with solid/dust formulations.

Table 5.3.1. Recommendations for the Residential Exposures for the Permethrin Aggregate Assessment.							
Lifestage	Exposure Scenario	Dose (mg/kg/day)[1]			MOE[2]		
		Inhalation	Oral	Total	Inhalation	Oral	Total
Adult	Post-application inhalation exposure following indoor barn misting system *initial application*	0.04177	N/A	**0.04177**	75	N/A	**75**
Children 1 to < 2 years old	Post-application incidental oral hand to mouth exposure to small cats.	N/A	0.1457	**0.1457**	300	N/A	**300**
ARI[3]							
Children 3 to < 6 years old	Post-application inhalation exposure following indoor barn misting system *normal infestation application rate*	0.02885	0.0010149	**0.02986**	110	43,000	**1.21**

1 Dose = the highest dose for each applicable lifestage of all residential scenarios assessed (rounded to 2 significant figures where applicable). Total = dermal + inhalation + incidental oral (where applicable).

2 MOE = the MOEs associated with the highest residential doses. Total = 1 ÷ (1/Dermal MOE) + (1/Inhalation MOE) + (1/Incidental Oral MOE), where applicable. Inhalation LOC = 30.

3 ARI = 1 ÷ [(Inhalation LOC 100/Inhalation MOE) + (Incidental oral LOC 300/Incidental Oral MOE)].

Cancer Aggregate Assessment

The following reflects the residential risk estimate that is recommended for use in the adult cancer aggregate assessment for permethrin.

- The greatest residential cancer risk estimate reflects post-application dermal exposure from contact with small cats treated with liquid formulations of permethrin which results in a LADD of 0.0048 mg/kg/day and a cancer risk estimate of 4.7×10^{-5}.

6.0 Non-Occupational Spray Drift Exposure and Risk Estimates

A quantitative spray drift assessment for permethrin is not required because the maximum application rate to a crop/target site (1.6 lbs ai/A for forestry applications) multiplied by the adjustment factor for drift of 0.26 is less than the maximum direct spray residential turf application rate (0.87 lb ai/A) for any permethrin products (1.6 lbs ai/A * 0.26 = 0.416 lbs ai/A < 0.87 lbs ai/A). There were no risks of concern for the residential turf assessment; therefore, the assessment to residues on turf is protective of exposure to the residue from spray drift.

7.0 Non-Occupational Bystander Post-Application Inhalation Exposure and Risk Estimates

Volatilization of pesticides may be a source of post-application inhalation exposure to individuals nearby pesticide applications. The agency sought expert advice and input on issues related to volatilization of pesticides from its Federal Insecticide, Fungicide, and Rodenticide Act Scientific Advisory Panel (SAP) in December 2009, and received the SAP's final report on March 2, 2010 (http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0687-0037). The agency has evaluated the SAP report and has developed a Volatilization Screening

Tool and a subsequent Volatilization Screening Analysis (http://www.regulations.gov/#!docketDetail;D=EPA-HQ-OPP-2014-0219). During Registration Review, the Agency will utilize this analysis to determine if data (i.e., flux studies, route-specific inhalation toxicological studies) or further analysis is required for permethrin.

The Agency has developed a preliminary bystander volatilization inhalation exposure assessment for permethrin utilizing the currently available inhalation toxicity and air monitoring data. Permethrin was detected in multiple ambient air studies. Reported detections include:

- Report of Ambient Air Monitoring for Pesticides in Lompoc, California
- Report for the Application (Butte County) and Ambient (Monterey County) Air Monitoring of Permethrin
- Pesticide Air Monitoring in Parlier, CA
- Air Monitoring Network Results for 2011: Volume 1

Details of each individual study are provided in Appendix C.

Application site air monitoring (i.e., also known as field volatility) refers to the collection of air samples around the edges of a treated field during and after a pesticide application. Samples are generally collected for short intervals (e.g., < 8 hours), for at least the first day or two after application with subsequent samples increasing in duration. In this type of study, it is typically known when an application occurred, the equipment used for the application, and the application rate. Application site monitoring data represents an exposure to vapors at or near the field edge resulting from an application.

Ambient air monitoring typically is focused on characterizing the airborne pesticide levels within a localized airshed or community structure of some definition (e.g., city, township, or municipality). This type of monitoring effort also can be focused on capturing chronic background levels or other temporal characteristics of interest such as focusing on seasonal pesticide use patterns. Typically, samples are generally taken for 24 consecutive hours and collected at the same site over an extended period of time (e.g., several weeks or months). In contrast to application site air monitoring, information on the precise timing and location of pesticide applications are rarely collected in ambient air monitoring studies. However, this does not mean that an application did not occur near an ambient sampler during the monitoring period.

The permethrin bystander volatilization inhalation exposure assessment compares the maximum 24-hour air concentration detected in each of the monitoring studies to the HEC for residential bystanders (32.991 mg/m^3). This comparison was done to represent a potential resident who lives next to a treated field and may be exposed to the peak concentration of permethrin volatilizing off the field over a 24-hour period. In addition, the arithmetic mean permethrin air concentration from each study was compared to the HEC for residential bystanders. This comparison was done to represent a potential seasonal exposure.

The toxicological profile of pyrethroids characterizes pyrethroids, including permethrin, as being rapid in onset and associated with acute, peak exposures. The single dose and repeat dosing studies show that repeat exposures do not result in lower points of departure (PODs) (i.e. there is

no evidence of increasing toxicity with an increased duration of exposure). As such, the totality of the information suggests that only single day (short-term) risk assessments need to be conducted for permethrin. Typically, maximum concentrations are compared to acute PODs, but in this case the acute and short term-PODs are the same, therefore the short-term POD was used for both. For the purposes of the post-application bystander inhalation quantitative assessment, only acute 24-hour post application ambient air concentrations were incorporated into Table 7.1 below, which provides permethrin volatilization MOE calculations for each site. None of the air concentrations results in risks of concern.

Table 7.1: Residential Bystander Preliminary Volatilization MOE Analysis of Permethrin.						
Study	Year of Study	Level of Detection (ng/m^3)	Level of Quantification (ng/m^3)	Duration of samples	Maximum Air Concentration (ng/m^3)[a]	Acute MOEs[b] **(LOC = 30)**
Ambient Air Data						
(CDPR and CARB) Lompoc, CA	2003	1.4	7.2	24-hour	trace (4.3)	7,700,000
(CDPR) Monterey, CA	1998	0.10	0.33	24-hour	trace (0.215)	153,400,000
(CDPR and CARB) Parlier, CA	2009	N/A	46.3	24-hour	trace (26.8)	1,200,000
(CDPR AMN) Salinas	2015	7.2	23.1	24-hour	not detected (3.6)	9,200,000
(CDPR AMN) Shafter		7.2	23.1		not detected (3.6)	9,200,000
(CDPR AMN) Ripon		7.2	23.1		trace (15.2)	2,200,000
(CDPR AMN) Salinas	2014	7.2	23.1	24-hour	not detected (3.6)	9,200,000
(CDPR AMN) Shafter		7.2	23.1		trace (15.2)	2,200,000
(CDPR AMN) Ripon		7.2	23.1		trace (15.2)	2,200,000
(CDPR AMN) Salinas	2013	7.2	23.1	24-hour	not detected (3.6)	9,200,000
(CDPR AMN) Shafter		7.2	23.1		not detected (3.6)	9,200,000
(CDPR AMN) Ripon		7.2	23.1		trace (15.2)	2,200,000
(CDPR AMN) Salinas	2012	7.2	23.1	24-hour	not detected (3.6)	9,200,000
(CDPR AMN) Shafter		7.2	23.1		not detected (3.6)	9,200,000
(CDPR AMN) Ripon		7.2	23.1		not detected (3.6)	9,200,000
(CDPR AMN) Salinas	2011	7.2	23.1	24-hour	not detected (3.6)	9,200,000
(CDPR AMN) Shafter		7.2	23.1		trace (7.9)	4,200,000
(CDPR AMN) Ripon		7.2	23.1		trace (7.9)	4,200,000
Application Study Data						
Butte, CA (CDPR)	1998	0.10	0.33	5-hour	0.57	57,900,000

a. All non-detects and trace concentrations reported as identified in the individual study reports. For non-detects, assumed 1/2 Limit of Detection (LOD). For trace concentrations, assumed concentration halfway between LOD and Limit of Quantitation of (LOQ) unless otherwise indicated by the study (see Appendix C for more details).

b. Acute MOE = Residential Bystander HEC (32,991,000,000 ng/m^3) / Study maximum air concentration (ng/m^3). LOC = 30

Some of the limitations and considerations that have been identified that should be considered in the interpretation of these results include:

- Most of the data utilized in this preliminary assessment are 24-hour air samples. When these data are used, an assumption is made that an individual is exposed to the same air concentration for 24-hours every day. However, this is not always the case as real world time-activity data indicate that many parts of the population move from site to site on a

daily basis (e.g., go to work and back).

- This assessment is only representative of outdoor concentrations (i.e., the exposure and risk estimates assume an individual is outdoors all the time). It does not take into account potential effects of air conditioning systems and similar air filtration systems which could potentially reduce air concentrations of permethrin indoors. The Agency believes that indoor concentrations will be at worst equivalent to outdoor concentrations and may potentially be lower.

- All of the data used for this analysis have been generated in California; however, permethrin is used in many regions of the country. Therefore, the results based on the limited available air monitoring data were used to represent the rest of the country due to a lack of adequate information for any other region. It is unclear what potential impacts this extrapolation might have on the risk assessment. Factors such as meteorology and cultural practices may impact the overall amounts of permethrin that volatilize from a treated field as well as the rate at which it volatilizes.

- The residential bystander estimated exposure should not be included in the human health risk assessment aggregate due to the fact that this is only a preliminary assessment and is not considered a refined assessment for the reasons noted above. There are limitations associated with the air monitoring data that are available, such as the fact that most are 24-hour air samples and that the measurement techniques do not distinguish between aerosols and vapors. In addition, as noted in the above bullet, this assessment assumes residents are outdoors during the entire exposure duration.

8.0 Occupational Exposure and Risk Estimates

8.1 Occupational Handler Exposure/Risk Estimates

HED uses the term handlers to describe those individuals who are involved in the pesticide application process. HED believes that there are distinct job functions or tasks related to applications and exposures can vary depending on the specifics of each task. Job requirements (amount of chemical used in each application), the kinds of equipment used, the target being treated, and the level of protection used by a handler can cause exposure levels to differ in a manner specific to each application event.

Based on the anticipated use patterns and current labeling, types of equipment and techniques that can potentially be used, occupational handler exposure is expected from the registered uses. For impregnated materials treated with non-biocide pesticides (e.g., insecticides and repellents), exposure during the manufacturing process is not assessed by EPA. The quantitative exposure/risk assessment developed for occupational handlers is based on the following representative scenarios further detailed in Appendix E, Table 8.1.1, 8.1.2, and 8.1.3.

Agricultural Uses

- Mixing/loading:

    - Water Dispersible Granules/Dry Flowables for:
        - Aerial applications for orchard/vineyards and typical/high acreage crops,
        - Airblast applications to orchard/vineyards,
        - Chemigation applications to orchard/vineyards and typical/high acreage crops,
        - Groundboom applications to orchard/vineyards and typical/high acreage crops,
    - Granules for:
        - Aerial applications to orchard/vineyards,
    - Liquid/Emulsifiable Concentrates and Wettable Powders for:
        - Aerial applications for orchard/vineyards and typical/high acreage crops,
        - Impregnation/coating of dry bulk fertilizer (commercial and on-farm)
        - Airblast applications to orchard/vineyards,
        - Chemigation applications to orchard/vineyards and typical/high acreage crops,
        - Groundboom applications to orchard/vineyards and typical/high acreage crops,
        - Stationary fogger applications to mushroom houses
- Applying:
    - Spray (all formulations):
        - Via aerial equipment orchard/vineyards and typical/high acreage crops,
        - Via airblast equipment to orchard/vineyards,
        - Via groundboom equipment orchard/vineyards and typical/high acreage crops,
    - Dry Bulk Fertilizer:
        - Via commercial treatment for typical/high acreage crops
        - Via on-farm treatment for typical/high acreage crops
    - Granules for:
        - Aerial applications to orchard/vineyards,
- Flagging:
    - All spray formulations for aerial applications to orchard/vineyards, and typical/high acreage crops,
    - Granular applications for aerial applications to orchard/vineyards
- Mixing/loading/applying:
    - Water Dispersible Granules/Dry Flowables for:
        - Backpack applications to orchard/vineyards
        - Mechanically-pressurized handgun applications to orchard/vineyards and typical field crops,
    - Liquid/ Emulsifiable Concentrates and Wettable Powder for:
        - Backpack applications to orchard/vineyards,
        - Stationary fogger applications to mushroom houses
        - Manually-pressurized handgun applications to mushroom houses
        - Mechanically pressurized handgun to turf, orchard/vineyards, typical acreage crops,
- Loading/Applying

- Granules for
  - Backpack, belly grinder, and rotary spreader applications to orchard/vineyards.

Non-Agricultural Uses

- Mixing/Loading
  - Water Dispersible Granules/Dry Flowables for:
    - Dip applications for livestock,
    - Aerial applications for forestry,
    - Chemigation and groundboom applications for greenhouse ornamentals,
  - Liquid/ Emulsifiable concentrates for:
    - Dip applications for livestock,
    - Aerial applications for aquatic and terrestrial vector control (mosquito adulticide public health uses) and forestry applications,
    - Truck mounted fogger applications for aquatic and terrestrial vector control,
    - Groundboom applications for golf courses, greenhouses, and field-grown ornamentals,
    - Boom sprayer applications for aquatic vector control,
    - Automatic misting systems for barns and outdoor residential areas,
    - Stationary foggers for warehouses and indoor barns,
  - Wettable Powders for:
    - Aerial applications for forestry,
    - Chemigation and groundboom applications for greenhouse ornamentals,
- Applying
  - RTU Dusts for:
    - Dust bag applications for livestock,
    - Shaker can applications for landscaping, livestock, and domestic animals
  - Spray (all formulations) for:
    - Aerial applications for aquatic and terrestrial vector control (mosquito adulticide public health uses) and forestry applications,
    - Truck mounted fogger applications for terrestrial vector control,
    - Groundboom applications for golf courses and greenhouse ornamentals,
    - Boom sprayer applications for aquatic vector control,
  - RTU Liquids for:
    - Dip applications to domestic animals,
    - Pour-in/on applications to livestock/domestic animals,
    - Shampoo applications to domestic animals,
    - Sponge applications to horses and domestic animals,
    - Spot-on applications to domestic animals,
    - Trigger spray bottle applications to horses, domestic animals, indoor surfaces (crack and crevice), and landscaping,
    - Wipe/towelette applications to domestic animals and horses,
  - RTU Granular
    - Shaker can applications to insect nests/mounds

    - RTU Pressurized Liquid
        - Aerosol can applications to military aircraft (cabin, crew, and cargo areas), domestic animals, foundations/perimeters, indoor living spaces (crack and crevice), outdoor residential spaces, and landscaping areas,
        - Total release fogger applications to warehouses,
    - RTU Solid
        - Ear-tag applications to livestock,
- Mixing/Loading/Applying
    - Water Dispersible Granules/Dry Flowables for:
        - Backpack applications to Christmas tree farms, conifer orchards,
        - Manually pressurized handwand applications to Christmas tree farms,
        - Mechanically pressurized handgun applications to Christmas tree farms and greenhouse ornamentals,
    - Liquid/ Emulsifiable concentrates for:
        - Backpack applications to greenhouse ornamentals, wildlife management areas, Christmas tree farms, forestry areas, landscaping areas (trees, shrubs, lawns, turf), termiticide structural uses, industrial areas, barns/feedlots, livestock, foundations/perimeters, and aquatic vector control,
        - Injector applications to structures for termiticide uses
        - Manually pressurized handwand applications to greenhouse ornamentals, wildlife management areas, Christmas tree farms, landscaping areas (interior/exterior, trees, shrubs, lawns, turf), food handling establishments, industrial areas, warehouses, barns/feedlots, livestock, foundations/perimeters, and insect mounds/nests,
        - Mechanically pressurized handgun applications to golf courses, Christmas tree farms, landscaping lawns/turf, livestock, and aquatic vector control,
    - Water Soluble Packets for:
        - Backpack, manually pressurized handwand, and mechanically pressurized handwand applications to Christmas tree farms, conifer orchards, and greenhouse ornamentals
- Loading/applying
    - Granules for:
        - Belly grinder applications to turf
        - Cup applications to insect mounds/nests
    - Paint/stain for:
        - Airless sprayer and brush/roller applications to residential and commercial structures

Additionally, there are seed treatment uses with a quantitative exposure and risk assessment for occupational handlers based on the following scenarios:

On-Farm Seed Treatment: Permethrin on-farm seed treatment utilizes planter and hopper box seed treatments only and are physically mixed by a worker with a stick or paddle.

Planting Treated Seed (Planters): Potential occupational exposure scenarios from the use of permethrin as a seed treatment include planting treated seed (secondary handler). Planting treated seed consists of the farmer placing the seed in the hopper and applying seed to fields and is considered a secondary handler exposure scenario.

Occupational Handler Non-Cancer Exposure Data and Assumptions

A series of assumptions and exposure factors served as the basis for completing the occupational handler risk assessments. Each assumption and factor is detailed below on an individual basis.

Application Rate:

A screening-level approach was used for this assessment of occupational exposures by evaluation of the maximum application rate for all possible occupational handler exposure scenarios of permethrin. A representative use site/group used to assess all of the registered uses of permethrin are provided in Appendix E, Tables 8.1.1, 8.1.2, and 8.1.3. All registered application rates for permethrin are detailed in Appendix A, Tables 4.1 and 4.2.

Unit Exposures:

It is the policy of HED to use the best available data to assess handler exposure. Sources of generic handler data, used as surrogate data in the absence of chemical-specific data, include PHED 1.1, AHETF database, the ORETF database, or other registrant-submitted occupational exposure studies. Some of these data are proprietary (e.g., AHETF data), and subject to the data protection provisions of FIFRA. The standard values recommended for use in predicting handler exposure that are used in this assessment, known as "unit exposures", are outlined in the "Occupational Pesticide Handler Unit Exposure Surrogate Reference Table[15]", which, along with additional information on HED policy on use of surrogate data, including descriptions of the various sources, can be found at the Agency website[16]. Seed treatment unit exposures were based on ExpoSAC Policy 14.

For the dry bulk fertilizer scenarios, HED assumes a closed mixing/loading scenario for commercial impregnation of dry bulk fertilizer, and an open mixing/loading scenario for grower-owned (i.e., on-farm) equipment impregnation of dry bulk fertilizer. For all applications of dry bulk fertilizer, HED assumes the use of an open-cab tractor spreader.

As HED does not have aircraft-specific exposure data, the Pesticide Handlers Exposure Database Version 1.1 (PHED 1.1) indoor exposure data has been used to assess applications to military aircraft cabin, crew, and cargo areas for the purposes of this assessment.

Area Treated or Amount Handled:

The daily areas treated or amounts handled were defined for each handler scenario (in appropriate units) by determining the amount that can be reasonably treated by an individual in a single day. When possible, the assumptions for daily areas treated or amounts handled are taken from the HED's ExpoSAC Policy 9.1: "Standard Values for Daily Acres Treated in Agriculture". The values used for area treated may be found in Appendix E, Table 8.1.1. The amounts

[15] Available: http://www.epa.gov/opp00001/science/handler-exposure-table.pdf
[16] Available: http://www.epa.gov/pesticides/science/handler-exposure-data.html

handled/treated for seed treatment were based on ExpoSAC Policy 15.1 and the BEAD memo: "Acres Planted per Day and Seeding Rates of Crops Grown in the United States" (J. Becker, et al; March 2011).

A literature article titled, "Demographic of United States Equine Population" (http://www.humanesociety.org/assets/pdfs/hsp/soaiv_07_ch10.pdf) indicates that the average number of horses boarded in a stable ranges from six to nineteen. HED assumed that a maximum of 25 horses would be treated per day. This is considered a conservative estimate to be protective of registered scenarios.

HED does not have data regarding the mixing/loading or the application of permethrin-impregnated dry bulk fertilizer. The mixing/loading processing rate for commercial impregnation of dry bulk fertilizer has been estimated to be 960 tons of fertilizer processed per 8-hour day based on information supplied by a registrant concerning the chemical alachlor.[17] Commercial/contract application of impregnated fertilizer is assessed assuming 320 acres/day (as determined by PHED Scenario 15/16). On-farm mixing/loading for, and application of, impregnation of dry bulk fertilizer is then assessed using an estimate of 160 acres/day.

Agricultural crop inputs for area treated were based on information in ExpoSAC Policy 9.1 and include:

- 1200 acres for aerial applications on high acreage field crops;
- 960 tons for commercial impregnation/coating of dry bulk fertilizer;
- 350 acres for aerial application on typical acreage field crops and orchards/vineyards;
- 350 acres for chemigation on high and typical acreage field crops and orchards/vineyards;
- 320 acres for commercial impregnation/coating of dry bulk fertilizer;
- 200 acres for groundboom applications on high acreage field crops;
- 160 acres for on-farm impregnation/coating of dry bulk fertilizer;
- 80 acres for groundboom applications on typical acreage field crops;
- 40 acres for groundboom applications on orchards/vineyards;
- 40 acres for airblast applications on orchards/vineyards;
- 1000 gallons sprayed via mechanically-pressurized handgun on typical acreage field crops; and
- 40 gallons sprayed via backpack sprayer on orchards/vineyards.
- Mushroom houses:
    - Backpack/ manually pressurized handwands: 40 gallons/day
    - Foggers: 1,000,000 ft^3

The following inputs are based on either the most recently conducted permethrin and TCVP occupational and residential exposure and risk assessment for similar use patterns[18] or best professional judgment of product usage:

[17] http://archive.epa.gov/pesticides/reregistration/web/pdf/0063fact.pdf
[18] C. Smith. Permethrin: Third Revision of the Occupational and Residential Exposure Assessment for the Reregistration Eligibility Decision Document. 4-APR-2006. D325428.

- All livestock applications: 400 animals treated daily
- Poultry livestock shaker can/dust bag: 1,000 birds or 1,000 square feet
- Self-treating dust bags for livestock: 10 filled daily (assuming a 12.5 lb dust bag) or 400 animals treated daily.
- Veterinary/groomer domestic animal applications: 8 dogs treated daily (1 per hour in 8 hour workday), 25 horses treated daily (10 gallons/day for dog dip)
- Veterinary/groomer aerosol can/trigger spray bottle: 2-16 oz cans/bottles
- Christmas tree/conifer pine tree orchards manually pressurized handwand/backpack applications: 5 acres
- Christmas tree mechanically pressurized handwand applications: 125 acres[19]
- Conifer pine tree orchard aerial applications: 125 acres
- Indoor residential RTU Foggers: 8-6 oz foggers (negligible exposure)
- Indoor residential RTU Aerosol Cans: 8-16 oz cans
- Indoor residential Trigger-spray bottles: 8 bottles
- Indoor residential Dust applications: 10 lbs
- Mounds/nests: 1000 linear ft/mounds
- Termites: 2000 gallons for injectors
- Paint/stain brush/roller applications: 5 gallons
- Paint/stain airless sprayer applications: 40 gallons
- Outdoor residential misting systems: 1000 gallons
- Barn Misting Systems/Stationary Foggers: 200,000 cu ft
- Barn manually pressurized handwand applications: 40 gallons
- Barn mechanically pressurized handwand applications: 1000 gallons
- Termites:
    - manually pressurized handwand/backpack applications: 1000 linear feet
    - injection: 2000 gallons

For seed treatment uses, the amount of active ingredient handled depends on the application rate as well as the amount of seed handled. For primary handlers (mixers/loaders), the number of seeds treated in a day (8-hour work shift) was based on ExpoSAC Policy 15.1, with 339,500 lbs of corn seeds and 281,250 lbs of soybeans treated in a day. For secondary handlers (planters), the number of seeds planted in a day (8-hour work shift) was based on the BEAD memo: "Acres Planted per Day and Seeding Rates of Crops Grown in the United States" (J. Becker, et al; March 2011), with 8,800 lbs of corn seeds (i.e., (59,739 seeds/acre/1,361 seeds/lb) * 200 acres/day), and 33,400 lbs of soybeans (i.e., (250,000 seeds/acre/1,500 seeds/lb) * 200 acres/day).

W. Britton. Tetrachlorvinphos: Final Occupational and Residential Exposure Assessment for Registration Review. 21-DEC-2016. D436833.

[19] Current PHED values: 1000 gallons (mechanically pressurized handgun) / 40 gallons (manually pressurized handwand) = 25:1 ratio. Therefore 5 acres (manually pressurized handwand) * 25 = 125 acres (mechanically pressurized handgun)

For military aircraft applications, the amount handled could potentially vary year-to-year based on operational tempo and the number of military missions to countries which require disinsection to be performed inside an aircraft prior to arrival. As a conservative estimate for the non-cancer risk estimate, using the largest US military aircraft[20] (C-5M Super Galaxy) as the application site, HED assumed up to four 100-g canisters[21] of product could be used.

Exposure Duration:
Occupational exposure is expected to be short- to intermediate term in duration. The single dose and repeat dosing permethrin studies show that repeat exposures do not result in lower PODs (i.e. there is no evidence of increasing toxicity with an increased duration of exposure). Therefore, for purpose of exposure assessments, only single day risk assessments need to be conducted for permethrin, and these are protective of scenarios in which exposure occurs for multiple days.

Mitigation/Personal Protective Equipment:
Estimates of dermal and inhalation exposure were calculated for various levels of PPE. However, all results are presented for "baseline," defined as a single layer of clothing consisting of a long sleeved shirt, long pants, shoes plus socks, no protective gloves, and no respirator. The registered permethrin labels require baseline attire.

Some labels require additional PPE depending on the use scenario and formulation[22] which are summarized below:

- For wettable powder, liquid, and dry flowable formulations:
    - Applicators using ULV cold foggers or fog/mist generators in indoor spaces must wear: Coveralls over long-sleeved shirt and long pants, chemical-resistant gloves, chemical resistant footwear plus socks, and chemical-resistant headgear, if overhead exposure.
    - Applicators using ULV cold foggers and/or fog/mist generators in outdoor spaces must wear: long-sleeve shirt and long pants, shoes plus socks, and chemical-resistant gloves.
    - All other mixers, loaders, applicators, and other handlers must wear: long-sleeve shirt and long pants, shoes plus socks, chemical-resistant gloves for all handlers except for applicators using motorized ground equipment, pilots, and flaggers, chemical-resistant apron for mixers/loaders, persons cleaning equipment, and persons exposed to the concentrate and for handlers performing animal dip applications.
- For granular formulations:
    - All loaders, applicators, and other handlers must wear: long-sleeve shirt and long pants, shoes plus socks, and chemical-resistant gloves for all handlers except for applicators using motorized ground equipment, pilots, and flaggers.

[20] http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104492/c-5-abc-galaxy-c-5m-super-galaxy.aspx
[21] A C-5M Super Galaxy has an approximate cargo hold volume of 880m^3. One canister of product treats 285m^3. Therefore, approximately 4 canisters are required to treat the aircrafts cargo hold (880 m^3 / 285 m^3 = 3.1 canisters + ~1 for cabin and crew areas)
[22] Summary of Labeling Changes for Permethrin (Revised 8/29/2011) resulting from the Reregistration Eligibility Decision (RED)

- For dust formulations:
    - Loaders, applicators, and other handlers must wear: long-sleeve shirt and long pants, shoes plus socks, chemical-resistant gloves, and a NIOSH-approved respirator with: a dust/mist filter with MSHA/NIOSH approval number prefix TC-21C or any N, R, P, or HE filter.
- For all engineering control scenarios:
    - Pilots must use an enclosed cockpit that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d)(6)].
- For Section 18 Military Aircraft:
    - No PPE is required according to the labels; however, the Section 18 application states, *"No personal protective equipment is required for minor exposure. Applicators who may have moderate exposures should wear safety glasses, coveralls or long sleeve shirt and pants, rubber or nitrile gloves. Although unlikely for this type of application, applicators who might expect to have heavy exposures should wear a respirator if concentration of gas/particulates in the breathing zone approaches or exceeds the Occupational Exposure Standard."*
    - As these exposure levels (minor, moderate, and heavy) are not defined on the label, all scenarios were assessed using baseline PPE defined as a long sleeved shirt, long pants, shoes, socks, no gloves, and no respirator.

Occupational Handler Non-Cancer Exposure and Risk Estimate Equations

The algorithms used to estimate non-cancer exposure and dose for occupational handlers can be found in Appendix G.

Combining Exposures/Risk Estimates

Dermal and inhalation exposures are expected from the occupational handling of permethrin. However, since there is no dermal hazard from permethrin exposure, only inhalation non-cancer exposure has been quantitatively assessed. Occupational handler cancer risk estimates are quantified based on both dermal and inhalation exposures. This is because, despite the determination of the lack of dermal hazard for permethrin, dermal exposures from permethrin must be quantified for the purpose of cancer risk assessment.

Summary of Occupational Handler Non-Cancer Exposure and Risk Estimates

All screening-level occupational handler non-cancer inhalation risks estimates are not of concern using engineering controls (for aerial applicators) or no respirator, with MOEs ranging from 31 to 240,000,000 (LOC $\leq$ 30).

Occupational Handler Cancer Exposure and Risk Equations

Days per Year of Exposure:

To assess cancer risk (both agricultural and non-agricultural uses), it is assumed that private growers would be exposed 10 days per year and commercial applicators would be exposed 30 days per year. The term "private grower" means that the grower or one of the workers would apply the pesticides to land owned or operated by the grower. "Commercial applicators" means the applicators are completing multiple applications for multiple clients.

Years per Lifetime of Exposure: It is assumed that handlers would be exposed for 35 years out of a 78-year lifespan.

Lifetime Expectancy: Life expectancy values are from the Exposure Factors Handbook 2011 Edition Table 18-1 (U.S. EPA, 2011). The table shows that the overall life expectancy is 78 years based on life expectancy data from 2007. In 2007, the average life expectancy for males was 75 years and 80 years for females. Based on the available data, the recommended value for use in cancer risk assessments is 78 years.

A DAF of 3.3% has been applied to estimate the dermal equivalent doses, and inhalation absorption is considered equivalent to oral absorption (100%) for the quantitative cancer assessment.

Cancer risk estimates were calculated using a linear low-dose extrapolation approach in which a Lifetime Average Daily Dose (LADD) is first calculated and then compared with a Q_1* that has been calculated for permethrin based on dose response data in the appropriate toxicology study (Q_1* = 9.567 x 10^{-3} $(mg/kg/day)^{-1}$). Absorbed average daily dose (ADD) levels were used as the basis for calculating the LADD values. Dermal and inhalation ADD values were first added together to obtain combined ADD values. LADD values were then calculated and compared to the Q_1* to obtain cancer risk estimates. The algorithms used to estimate the LADD and cancer risk for occupational handlers can be found in Appendix H.

Summary of Occupational Handler Cancer Exposure and Risk Estimates

Agricultural Uses
The cancer occupational handler risk estimates for the registered crops and crop groups ranged from 1×10^{-8} to 5×10^{-5} to for private growers (10 days of exposure/year) and 3×10^{-8} to 2×10^{-4} for commercial applicators (30 days of exposure/year). Occupational handler manually-pressurized handwand applications (broadcast) to mushroom houses using liquid or wettable powder formulations result in the highest cancer risk estimate.

Non-Agricultural Uses
The cancer occupational handler risk estimates for the registered use sites ranged from 2×10^{-9} to 1×10^{-3} for commercial handlers. Occupational handler manually-pressurized handwand applications (spot) to insect mounds/nests using liquid formulations result in the highest cancer risk estimate.

A detailed summary of occupational handler non-cancer and cancer risk estimates is presented in Appendix E, Tables 8.1.1, 8.1.2 and 8.1.3.

The Agency matches quantitative occupational exposure assessment with appropriate characterization of exposure potential. While HED presents quantitative risk estimates for human flaggers where appropriate, agricultural aviation has changed dramatically over the past two decades. According the 2012 National Agricultural Aviation Association (NAAA) survey of

their membership, the use of GPS for swath guidance in agricultural aviation has grown steadily from the mid 1990's. Over the same time period, the use of human flaggers for aerial pesticide applications has decreased steadily from ~15% in the late 1990's to only 1% in the most recent (2012) NAAA survey. The Agency will continue to monitor all available information sources to best assess and characterize the exposure potential for human flaggers in agricultural aerial applications.

HED has no data to assess exposures to pilots using open cockpits. The only data available is for exposure to pilots in enclosed cockpits. Therefore, risks to pilots are assessed using the engineering control (enclosed cockpits) and baseline attire (long-sleeve shirt, long pants, shoes, and socks); per the Agency's Worker Protection Standard stipulations for engineering controls, pilots are not required to wear protective gloves for the duration of the application. With this level of protection, there are currently no risk estimates of concern for applicators.

8.2 Occupational Post-Application Exposure/Risk Estimates

HED uses the term post-application to describe exposures that occur when individuals are present in an environment that has been previously treated with a pesticide (also referred to as re-entry exposure). Such exposures may occur when workers enter previously treated areas to perform job functions, including activities related to crop production, such as scouting for pests or harvesting. Post-application exposure levels vary over time and depend on such things as the type of activity, the nature of the crop or target that was treated, the type of pesticide application, and the chemical's degradation properties. In addition, the timing of pesticide applications, relative to harvest activities, can greatly reduce the potential for post-application exposure.

8.2.1 Occupational Post-Application Inhalation Exposure/Risk Estimates

Agricultural Uses:
There are multiple potential sources of post-application inhalation exposure to individuals performing post-application activities in previously treated fields. These potential sources include volatilization of pesticides and resuspension of dusts and/or particulates that contain pesticides. The agency sought expert advice and input on issues related to volatilization of pesticides from its Federal Insecticide, Fungicide, and Rodenticide Act Scientific Advisory Panel (SAP) in December 2009, and received the SAP's final report on March 2, 2010 (http://www.epa.gov/scipoly/SAP/meetings/2009/120109meeting.html). The agency has evaluated the SAP report and has developed a Volatilization Screening Tool and a subsequent Volatilization Screening Analysis (http://www.regulations.gov/#!docketDetail;D=EPA-HQ-OPP-2014-0219). During Registration Review, the agency will utilize this analysis to determine if data (i.e., flux studies, additional route specific inhalation toxicity studies) or further analysis is required for permethrin.

In addition, the Agency is continuing to evaluate the available post-application inhalation exposure data generated by the Agricultural Reentry Task Force. Given these two efforts, the Agency will continue to identify the need for and, subsequently, the way to incorporate occupational post-application inhalation exposure into the agency's risk assessments.

Furthermore, inhalation exposure during dusty mechanical activities such as shaking and mechanical harvesting is another potential source of post-application inhalation exposure. However, the airblast applicator scenario is believed to represent a reasonable worst case surrogate estimate of post-application inhalation exposure during these dusty mechanical harvesting activities. The non-cancer inhalation risk estimate for commercial airblast application is not of concern (i.e., MOE > 100)

Public Health Uses:
As post-application inhalation exposure for occupational workers would result in similar exposures as non-occupational bystanders and residential post application exposure scenarios, the AgDisp post-application assessment in section 5.2 is considered protective of any potential occupational post-application exposure from public health uses. Additionally, using the 1-hour average air concentration from AgDisp modeling for permethrin and comparing it to the occupational HEC, no risks of concern are identified ((HEC: 98.973 mg/m3) / (AgDisp 1-hour air concentration: 0.0014 mg/m3) = 70,695 MOE).

Greenhouse Uses:
The Worker Protection Standard for Agricultural Pesticides contains requirements for protecting workers from inhalation exposures during and after greenhouse applications through the use of ventilation requirements. [40 CFR 170.110, (3) (Restrictions associated with pesticide applications)]

Seed Treatment Uses:
A post-application inhalation exposure assessment is not required as exposure is expected to be negligible. Seed treatment assessments provide quantitative inhalation exposure assessments for seed treaters and secondary handlers (i.e., planters). It is expected that these exposure estimates would be protective of any potential low-level post-application inhalation exposure that could result from these types of applications.

Non-Agricultural Commercial Uses:
Commercial applicators do not typically return to the treated areas after non-agricultural commercial pesticide applications (sites such as warehouses, food handling establishments, military aircraft, hotels, lawns/landscaping etc.) and thus an occupational post-application inhalation exposure assessment was not performed for commercial applicators.

8.2.2 Occupational Post-application Dermal Exposure/Risk Estimates

Non-Cancer Occupational Post-Application Dermal Exposure/Risk Estimates
No hazard was identified for dermal exposure for a quantitative non-cancer dermal post-application exposure assessment. In addition, commercial applicators do not typically return to the treated areas after a commercial pesticide application (sites such as warehouses, food handling establishments, military aircraft, hotels, etc.). Thus, a quantitative non-cancer occupational post-application dermal exposure assessment for non-agricultural uses was not performed for commercial applicators.

Restricted Entry Interval

Permethrin is classified as Toxicity Category III via the dermal route and Toxicity Category IV for skin irritation potential. It is not a skin sensitizer. Under 40 CFR 156.208 (c) (2), ai's classified as Acute III or IV for acute dermal, eye irritation and primary skin irritation are assigned a 12-hour REI. Therefore, the [156 subpart K] Worker Protection Statement interim REI of 12 hours is adequate to protect agricultural workers from post-application exposures to permethrin. HED would recommend a REI of 12 hours. This is the REI listed on the registered labels, and is considered protective of post-application exposure.

Cancer Occupational Post-Application Dermal Exposure/Risk Estimates

A series of assumptions and exposure factors served as the basis for completing the occupational post-application cancer risk assessments. Each assumption and factor is detailed below on an individual basis.

Transfer Coefficients: It is the policy of HED to use the best available data to assess post-application exposure. Sources of generic post-application data, used as surrogate data in the absence of chemical-specific data, are derived from ARTF exposure monitoring studies, and, as proprietary data, are subject to the data protection provisions of FIFRA. The standard values recommended for use in predicting post-application exposure that are used in this assessment, known as "transfer coefficients", are presented in the ExpoSAC Policy 3[23]" which, along with additional information about the ARTF data, can be found at the Agency website[24]. Table 8.2.2.2 provides a summary of the anticipated post-application activities and associated transfer coefficients for the registered crops/use sites.

Some scenarios assessed do not currently have available transfer coefficient data, as explained in the *Non-Foliar Transfer Coefficient Table* in ExpoSAC Policy 3, and are not quantitatively assessed herein:

- Hand pruning: pome trees, citrus trees, and nut trees,
    - Transfer coefficients for dormant pruning are unavailable.
- Hand harvesting: root vegetables (e.g., potatoes)
    - Harvesting occurs following defoliation, and exposure results via contact with residues in the soil, for which transfer coefficients are currently unavailable.
- Mechanical sweeping and Windrowing: tree nuts
    - Exposure during nut sweeping and windrowing results from contact with soil, for which transfer coefficients are currently unavailable.

Application Rate:

A screening-level approach was used for the assessment of occupational exposures by evaluation of the maximum application rate for all possible exposure scenarios of permethrin. The registered application rates are based on the scenarios listed in Appendix A, Table 4.1 and 4.2.

Exposure Time: The average occupational workday is assumed to be 8 hours.

[23] Available: https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/occupational-pesticide-handler-exposure-data
[24] Available: https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/occupational-pesticide-handler-exposure-data

Turf Transferable Residues:
Post-application exposures from golf courses were assessed using 0-day residue data from a turf transferable residue study conducted with a liquid permethrin product (MRID 44955501). Corrected TTR values have been reassessed to incorporate current regression modeling into this assessment resulting in day-0 TTR of 0.061 µg/cm^2 at the study application rate of 0.87 lbs ai/acre. Additional information is available in section 5.2 and summarized in Table 5.2.1.

Dislodgeable Foliar Residues:
For agricultural post-application scenarios, chemical-specific DFR data are available for four pyrethroids: cyfluthrin, fluvalinate, esfenvalerate, and permethrin. Most of these DFR data were collected on orchard crops (i.e., stone fruits, apples, oranges) or in greenhouses. The esfenvalerate DFR data underwent secondary review[25] and included analysis of foliar residues on corn and broccoli and are considered most representative of potential field crops that could be found in an agricultural setting which are identified in Table 8.2.2.2. However, the permethrin DFR data[26] included analysis of foliar residues on orchard crops (i.e., peaches) and are considered most representative of potential residues that could be found on fruit and nut tree foliage. Table 8.2.2.1 summarizes the available pyrethroid DFR data.

Table 8.2.2.1. Pyrethroid DFR Summary

Chemical	Study	Sites	Day 0 DFR (ug/cm^2)	Decay Constant (k)	Daily Dissipation (%)	Half Life (days)
Esfenvalerate	Dissipation of Dislodgeable Foliar Residues of Esfenvalerate from Broccoli Following Application of Asana® XL Insecticide in the USA - Season 1997 (MRID 44852402)	CA (Trial 1)	0.191	-0.219	20%	3.2
		CA (Trial 2)	0.123	-0.144	13%	4.8
	Dissipation of Dislodgeable Foliar Residues of Esfenvalerate from Sweet Corn Following Application of Asana® XL Insecticide in the USA - Season 1998 (MRID 44852403)	**CA (L)**	**0.221**	**-0.199**	**18%**	**3.5**
		PA (L)	0.157	-0.181	17%	3.8
Permethrin	Dissipation of Dislodgeable Foliar Residues of Permethrin Applied to Orchards (Peaches) (MRID 437557-01)	CA (EC)	0.309	-0.029	3%	24.2
		CA (W)	0.455	-0.025	2%	28.2
		GA (W)	0.712	-0.060	6%	11.5
		WA (W)	1.385	-0.047	5%	14.6
		Average*	**0.715**	**-0.040**	**4%**	**17.2**

* Calculated as [CA (EC) + CA (W) + GA (W) + WA (W)] ÷ 4
**Bolded values were used to calculate typical doses for the cancer risk estimates.

[25] B. O'Keefe 06-OCT-2003, D283191; B. O'Keefe 06-MAR-2003, D283188
[26] Dissipation of Dislodgeable Foliar Residues of Permethrin Applied to Orchards (Peaches). EPA MRID 437557-01. T. Belcher, *et. al.*, 20-JUL-1995

The dermal dose used for the occupational post-application cancer risk estimate was calculated using a 30-day average dose. This was calculated by adding the Day-0 dermal dose (see Appendix G for algorithms) with dermal doses from days 1 through 30 dissipated at the daily rate indicated in Table 8.2.2.1 above and then averaging the resulting value for each individual scenario.

Days per Year of Exposure:
To assess cancer risk, it is assumed that post-application scenarios could occur approximately 30 days a year at a 30-day average dose to calculate post-application risk estimates (B. Bobowiec, 16-OCT-2015; D429731).

Years per Lifetime of Exposure: HED assumes that post-application workers would be exposed for 35 years out of a 78-year lifespan.

Lifetime Expectancy: Based on available data from EPA's Exposure Factors Handbook 2011 Edition, the recommended lifespan for use in cancer risk assessments is 78 years. Life expectancy values are derived from the Exposure Factors Handbook 2011 Edition Table 18-1 (U.S. EPA, 2011). The table shows that the overall life expectancy is 78 years based on life expectancy data from 2007. In 2007, the average life expectancy for males was 75 years and 80 years for females.

A DAF of 3.3% has been applied to estimate the dermal equivalent doses, and inhalation absorption is considered equivalent to oral absorption (100%) for the quantitative cancer assessment.

Occupational Post-Application Cancer Dermal Exposure and Risk Equations
As was done for occupational handlers, post-application cancer risk estimates were calculated using a linear low-dose extrapolation approach in which a LADD is first calculated and then compared with a Q_1^* that has been calculated for permethrin based on dose response data in the appropriate toxicology study ($Q_1^* = 9.567\times10^{-3}$ (mg/kg/day)$^{-1}$). The algorithms used to estimate the LADD and cancer risk for occupational workers can be found in Appendix H.

Occupational Post-Application Cancer Dermal Risk Estimates
The cancer post-application risk estimates for the registered crops and crop groups ranged from 1×10^{-9} to 4×10^{-6} using the average 30-day dose. The forestry post-application activity of hand set irrigation result in the highest cancer risk estimate.

Table 8.2.2.2. Occupational Post-Application Cancer Exposure and Risk Estimates for Permethrin.

Crop Grouping/Crop (Application Rate)	Activity	Transfer Coefficient (cm^2/hr)	30-Day Average Dose	
			Dermal LADD (mg/kg/day)[1]	Cancer Risk Estimate[2]
Permethrin Peach DFR Data (MRID 437557-01)				
Papaya (0.15 lbs ai/acre)	orchard maintenance, hand weeding	100	1.90E-06	2E-08
	scouting, hand pruning	580	1.10E-05	1E-07
	hand harvesting	1400	2.66E-05	3E-07
	transplanting	230	4.38E-06	4E-08
Cherry (0.2 lbs ai/acre)	orchard maintenance, hand weeding, bird control, and propping	100	2.54E-06	2E-08

Table 8.2.2.2. Occupational Post-Application Cancer Exposure and Risk Estimates for Permethrin.				
Crop Grouping/Crop (Application Rate)	**Activity**	**Transfer Coefficient (cm^2/hr)**	**30-Day Average Dose**	
			Dermal LADD (mg/kg/day)[1]	**Cancer Risk Estimate[2]**
	Scouting, hand pruning, scouting, training	580	1.47E-05	1E-07
	thinning fruit	3600	9.13E-05	9E-07
	hand harvesting	1400	3.55E-05	3E-07
	transplanting	230	5.84E-06	6E-08
Christmas Tree (0.2 lbs ai/acre)	irrigation (hand set)	1900	4.82E-05	5E-07
	scouting, shaping	580	1.47E-05	1E-07
	hand weeding, grading/tagging	100	2.54E-06	2E-08
	hand harvesting	1400	3.55E-05	3E-07
	transplanting	230	5.84E-06	6E-08
Pecans (0.2 lbs ai/acre)	mechanical harvesting (shaking)	190	4.82E-06	5E-08
	poling, orchard maintenance, hand weeding	100	2.54E-06	2E-08
	hand pruning, scouting	580	1.47E-05	1E-07
	transplanting	230	5.84E-06	6E-08
Tree Nuts Almond, Hazelnut, Walnut (0.25 lbs ai/acre)	orchard maintenance, poling, hand weeding	100	3.17E-06	3E-08
	scouting	580	1.84E-05	2E-07
	transplanting	230	7.29E-06	7E-08
Deciduous Fruit Trees Apple, Nectarine, Peach, Pear (0.25 lbs ai/acre)	Scouting, hand pruning, training	580	1.84E-05	2E-07
	orchard maintenance, propping, hand weeding	100	3.17E-06	3E-08
	hand harvesting	1400	4.44E-05	4E-07
	transplanting	230	7.29E-06	7E-08
	thinning fruit	3600	1.14E-04	1E-06
Pistachio (0.3 lbs ai/acre)	orchard maintenance, hand weeding	100	3.81E-06	4E-08
	hand harvesting (net)	1400	5.33E-05	5E-07
	scouting	580	2.21E-05	2E-07
	mechanical harvesting (shaking)	190	7.23E-06	7E-08
	transplanting	230	8.75E-06	8E-08
Conifer pine seed orchard (1.6 lbs ai/acre)	harvesting seed cone (conifers)	1400	2.84E-04	3E-06
	harvesting seedling production	6700	4.54E-05	4E-07
	hand pruning (high/full), scouting	580	1.18E-04	1E-06
	hand weeding	100	2.03E-05	2E-07
	hand set irrigation	1900	3.86E-04	4E-06
	transplanting	230	4.67E-05	4E-07
Esfenvalerate Broccoli and Sweet Corn DFR (MRID 448524-02 and 448524-03)				
Kiwifruit (0.007 lbs ai/acre)	scouting, hand pruning, hand weeding, tying/training	640	4.11E-07	4E-09
	hand harvesting	10100	6.48E-06	6E-08
	transplanting	230	1.48E-07	1E-09
Asparagus (0.1 lbs ai/acre)	hand weeding	70	6.42E-07	6E-09
	hand set irrigation	1900	1.74E-05	2E-07
	scouting	210	1.93E-06	2E-08
	hand harvesting	1100	1.01E-05	1E-07
	transplanting	230	2.11E-06	2E-08
Head and Stem Brassica Brussel Sprouts, Cauliflower (0.1 lbs ai/acre)	scouting (low/full), hand harvesting, topping, hand weeding, tying/training	4200	3.85E-05	4E-07
	hand set irrigation	1900	1.74E-05	2E-07
	scouting (low/min), thinning plants	330	3.03E-06	3E-08
	transplanting	230	2.11E-06	2E-08
	hand weeding (cauliflower low/min)	1400	1.28E-05	1E-07
Collards (0.15 lbs ai/acre	hand set irrigation	1900	2.61E-05	2E-07
	scouting	210	2.89E-06	3E-08
	hand harvesting	1100	1.51E-05	1E-07
	hand weeding, thinning plants	70	9.63E-07	9E-09
	transplanting	230	3.16E-06	3E-08
Field/Row Crop (tall) Corn (pop, field)	hand set irrigation	1900	2.61E-05	2E-07
	scouting (high/full)	1100	1.51E-05	1E-07

Table 8.2.2.2. Occupational Post-Application Cancer Exposure and Risk Estimates for Permethrin.					
Crop Grouping/Crop (Application Rate)		**Activity**	**Transfer Coefficient (cm^2/hr)**	**30-Day Average Dose**	
				Dermal LADD (mg/kg/day)[1]	**Cancer Risk Estimate[2]**
(0.15 lbs ai/acre)		scouting (low/min and low/full)	210	2.89E-06	3E-08
		hand weeding	70	9.63E-07	9E-09
Fruiting Vegetables Eggplant (0.15 lbs ai/acre)		hand harvesting	550	7.56E-06	7E-08
		hand pruning, scouting, thinning fruit, hand weeding	90	1.24E-06	1E-08
		hand set irrigation	1900	2.61E-05	2E-07
		transplanting	230	3.16E-06	3E-08
Root Vegetables Turnip (0.15 lbs ai/acre)		hand harvesting	1100	1.51E-05	1E-07
		hand set irrigation	1900	2.61E-05	2E-07
		scouting	210	2.89E-06	3E-08
		hand weeding, thinning plants	70	9.63E-07	9E-09
Field/Row Crop (low/medium) Alfalfa, Soybean (0.2 lbs ai/acre)		hand set irrigation	1900	3.48E-05	3E-07
		scouting	1100	2.02E-05	2E-07
		hand weeding (soybean only)	70	1.28E-06	1E-08
Vine/Trellis Highbush Blueberry, Raspberry (0.2 lbs ai/acre)		scouting, hand weeding, hand pruning, bird control, frost control, tying/training (high, low/min)	640	1.17E-05	1E-07
		hand harvesting, tying/training (high/full)	1400	2.57E-05	2E-07
		hand set irrigation	1900	3.48E-05	3E-07
		transplanting	230	4.22E-06	4E-08
Head and Stem Brassica Broccoli, Cabbage (0.2 lbs ai/acre)		scouting (low/full), hand harvesting, hand weeding (low/full)	4200	7.70E-05	7E-07
		hand set irrigation	1900	3.48E-05	3E-07
		scouting (low/min), thinning plants	330	6.05E-06	6E-08
		transplanting	230	4.22E-06	4E-08
		hand weeding (low/min), scouting (cabbage low/min), hand harvesting (cabbage low/min), mechanically-assisted harvesting	1400	2.57E-05	2E-07
Leafy Vegetables Cabbage, Celery, Leafy Greens, Lettuce, Spinach (0.2 lbs ai/acre)		transplanting	230	4.22E-06	4E-08
		hand set irrigation	1900	3.48E-05	3E-07
Leafy Vegetables (0.2 lbs ai/acre)	Cabbage	hand harvesting, scouting (low/full), hand weeding (low/min)	1400	2.57E-05	2E-07
		scouting (low/min), thinning plants	330	6.05E-06	6E-08
		hand weeding (low/full)	4200	7.70E-05	7E-07
	Celery, Leafy Greens, Lettuce, Spinach	scouting	210	3.85E-06	4E-08
		hand harvesting	1100	2.02E-05	2E-07
		hand weeding, thinning plants	70	1.28E-06	1E-08
Cucurbit Vegetables Cantaloupe, Cucumber, Pumpkin, squash, watermelon (0.2 lbs ai/acre)		hand set irrigation	1900	3.48E-05	3E-07
		scouting, thinning fruit, hand pruning, hand weeding	90	1.65E-06	2E-08
		hand harvesting, mechanically-assisted harvesting, training/turning	550	1.01E-05	1E-07
		transplanting	230	4.22E-06	4E-08
Field/Row Crop (tall) Corn (sweet grain/processing) (0.2 lbs ai/acre)		hand set irrigation	1900	3.48E-05	3E-07
		scouting (high/full)	1100	2.02E-05	2E-07
		scouting (low/full, low/min)	210	3.85E-06	4E-08
		hand detasseling, hand harvesting	8800	1.61E-04	2E-06
		hand weeding	70	1.28E-06	1E-08
Fruiting Vegetables Bell Pepper, Tomato (0.2 lbs ai/acre)		hand harvesting, tying/training	1100	2.02E-05	2E-07
		hand set irrigation	1900	3.48E-05	3E-07
		scouting	210	3.85E-06	4E-08
		hand weeding, hand pruning	70	1.28E-06	1E-08
		transplanting	230	4.22E-06	4E-08
Root Vegetables Potato		hand set irrigation	1900	3.48E-05	3E-07
		scouting	210	3.85E-06	4E-08

Table 8.2.2.2. Occupational Post-Application Cancer Exposure and Risk Estimates for Permethrin.				
Crop Grouping/Crop (Application Rate)	**Activity**	**Transfer Coefficient (cm^2/hr)**	**30-Day Average Dose**	
			Dermal LADD (mg/kg/day)[1]	**Cancer Risk Estimate[2]**
(0.2 lbs ai/acre)	hand weeding	70	1.28E-06	1E-08
Stem/Stalk Vegetables Artichoke (0.3 lbs ai/acre)	hand harvesting	1100	3.03E-05	3E-07
	hand pruning, hand weeding	70	1.93E-06	2E-08
	hand set irrigation	1900	5.23E-05	5E-07
	scouting	210	5.78E-06	6E-08
	transplanting	230	6.33E-06	6E-08
Root Vegetables Onions (0.3 lbs ai/acre)	hand set irrigation	1900	5.23E-05	5E-07
	scouting, hand weeding (low/min)	1400	3.85E-05	4E-07
	hand weeding (low/full)	4200	1.16E-04	1E-06
	scouting, thinning plants	330	9.08E-06	9E-08
Permethrin TTR Data (MRID 449555-01)				
Golf Course (0.79 lbs ai/acre)	maintenance	3700	7.74E-06	7E-08
	maintenance (greens only)	2500	5.23E-06	5E-08

1 Dermal LADD (mg/kg/day) = 30 day average dermal dose (mg/kg/day) × [Days per year of exposure (30 days/yr) ÷ 365 days/year] × [Years per lifetime of exposure (35 yrs) ÷ Lifetime expectancy (78yrs)].

2 Cancer risk estimate = Dermal LADD (mg/kg/day) × Q_1^*, where Q_1^* = **9.567×10-3** $(mg/kg/day)^{-1}$.

APPENDIX A. Permethrin Use Pattern Tables

Table 4.1. Summary of Directions for Food Uses of Permethrin.						
Crop/Use Site	Application Type and Equipment	Formulation	Maximum Application Rate	Max # App. per Season	Max. Seasonal Application Rate	Use Directions[1]
Agricultural Crops						
Alfalfa	Aerial, chemigation, groundboom, tractor drawn spreader	EC, WP	0.20 lb ai/A	1 per cutting	0.20 lb ai per cutting	RTI = 30 days
		DF	0.05 lb ai/A			
		RTU (ULV)	0.007 lb ai/A			
Almond	Aerial, airblast, backpack, chemigation, groundboom, mechanically pressurized handgun	EC	0.0033 lbs ai/gal 0.0002 lbs ai/12 fl oz 0.25 lb ai/A		0.75 lb ai/A	RTI = 10 days
		G	0.25 lb ai/A			
		RTU (ULV)	0.007 lbs ai/A			
Amaranth, Chinese	Aerial, chemigation, groundboom	EC	0.20 lb ai/A			
		L	0.0036 lbs ai/gal			
		RTU (ULV)	0.142 lb ai/A			
		WP	0.20 lb ai/A			
Apple	Aerial, airblast, backpack, chemigation, groundboom, mechanically pressurized handgun	EC	0.0033 lbs ai/gal 0.25 lb ai/A 0.0002 lbs ai/12 floz		0.5 lb ai/A	RTI = 10 days
		RTU (ULV)	0.007 lb ai/A			
		WDG, WP	0.25 lb ai/A			
Artichoke	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.30 lb ai/A		0.9 lb ai/A	RTI = 10 days
		RTU (ULV)	0.007 lb ai/A			
Asparagus	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC	0.10 lb ai/A 0.0027 lbs ai/gal		0.40 lb ai/A	RTI = 7 days
		RTU (ULV)	0.007 lb ai/A			
		WDG, WP	0.10 lb ai/A			
Avocado		EC, WDG, WP	0.2 lb ai/A	6 (RED)	0.80 lb ai/A	RTI = 7 days

Table 4.1. Summary of Directions for Food Uses of Permethrin.						
Crop/Use Site	Application Type and Equipment	Formulation	Maximum Application Rate	Max # App. per Season	Max. Seasonal Application Rate	Use Directions[1]
	Aerial, airblast, backpack, chemigation, groundboom, mechanically pressurized handgun	RTU (ULV)	0.007 lb ai/A			
Blueberry	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC	0.20 lb ai/A 0.0036 lbs ai/gal			
Broccoli (including chinese)	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.20 lb ai/A 0.0018 lbs ai/ gal	5 (RED)	0.80 lb ai/A	RTI = 5 days
		RTU (ULV)	0.007 lb ai/A			
Brussel sprouts	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.10 lb ai/A 0.0018 lbs ai/gal	4 (RED)	0.40 lb ai/A	RTI = 5 days
		RTU (ULV)	0.007 lb ai/A			
Cabbage (including Chinese)	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.20 lb ai/A 0.0018 lbs ai/gal	2 (4 in HI)	0.40 lb ai/A (0.80 in HI)	RTI = 5 days
		RTU (ULV)	0.007 lb ai/A			
Cantaloupe	Aerial, groundboom	EC, WP	0.20 lb ai/A	4 (6 in HI)	0.8 (1.20 in HI)	RTI = 7 days
Cardoon	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.20 lb ai/A			
Cauliflower	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.1 lb ai/A 0.0018 lbs ai/gal	4 (6 in HI)	0.40 (0.60 in HI)	RTI = 5 days
		RTU (ULV)	0.007 lb ai/A			
Celery	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.20 lb ai/A 0.0036 lbs ai/gal	5 (6 in HI)	1.0 (1.2 in HI)	RTI = 7 days
		RTU (ULV)	0.007 lb ai/A			
Celtuce, Swiss Chard, Chervil, Cress (Garden, Upland, Water), Dandelion, Dock (sorrel), Fennel, Leafy Vegetables, Okra, Okra (Chinese), Parsley, Purslane	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.20 lb ai/A 0.0036 lbs ai/gal			
		RTU (ULV)	0.007 lb ai/A			

Table 4.1. Summary of Directions for Food Uses of Permethrin.						
Crop/Use Site	Application Type and Equipment	Formulation	Maximum Application Rate	Max # App. per Season	Max. Seasonal Application Rate	Use Directions[1]
(Garden, Winter), Rhubarb, Roquette (arugula), Spinach,						
Chayote, Chicory, Radicchio,	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.20 lb ai/A			
Cherries: sour & sweet	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.20 lb ai/A		0.6 lb ai/A	RTI = 10 days
		RTU (ULV)	0.007 lb ai/A			
Cole Crops	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC	0.15 lb ai/A 0.0018 lbs ai/gal			
		RTU (ULV)	0.007 lb ai/A			
Collards	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.15 lb ai/A		0.45 lb ai/A	RTI = 3 days
Corn (field, popcorn, seed)	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader, truck mounted fogger, backpack fogger	EC	0.15 lb ai/A 0.000015 lbs ai/linear ft		0.45 lb ai/A	RTI = 7 days
		G	0.15 lb ai/A 0.000011 lbs ai/linear ft			
		RTU (ULV)	0.007 lb ai/A			
		WDG, WP	0.15 lb ai/A 0.000012 lb ai/linear ft			
Sweet Corn (sweet: fresh & processed, unspecified)	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader, truck mounted fogger, backpack fogger	EC, WDG, WP	0.20 lb ai/A 0.0027 lbs ai/gal		0.8 lb ai/A	RTI = 3 days
		G	0.20 lb ai/A 0.000015 lbs ai/linear ft			
		RTU (ULV)	0.007 lb ai/A			
Corn Salad (mache)	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader, truck mounted fogger, backpack fogger	EC, WDG, WP	0.20 lb ai/A 0.0036 lbs ai/gal			
Cucumbers	Aerial, chemigation, groundboom, mechanically pressurized handgun,	EC, WDG, WP	0.20 lb ai/A 0.0036 lbs ai/gal		1.2 lb ai/A	RTI = 7 days

Table 4.1. Summary of Directions for Food Uses of Permethrin.						
Crop/Use Site	Application Type and Equipment	Formulation	Maximum Application Rate	Max # App. per Season	Max. Seasonal Application Rate	Use Directions[1]
	tractor drawn spreader, truck mounted fogger, backpack fogger	RTU (ULV)	0.007 lb ai/A			
Cucurbit Vegetables	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader, truck mounted fogger, backpack fogger	EC, WDG, WP	0.20 lb ai/A 0.0036 lbs ai/gal			
		RTU (ULV)	0.007 lb ai/A			
Eggplant	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader, truck mounted fogger, backpack fogger	EC, WDG, WP	0.15 lb ai/A 0.0055 lbs ai/gal		0.6 lb ai/A (1.0 lb ai/A in HI)	RTI = 7 days
		RTU (ULV)	0.007 lb ai/A			
Endive (Escarole)	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader, truck mounted fogger, backpack fogger	EC, WDG, WP	0.20 lb ai/A 0.0036 lbs ai/gal			
		RTU (ULV)	0.007 lb ai/A			
Garlic	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader, truck mounted fogger, backpack fogger	EC, WDG, WP	0.2 lb ai/A		0.8 lb ai/A	RTI = 10 days
		RTU (ULV)	0.007 lb ai/A			
Gherkin	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader, truck mounted fogger, backpack fogger	EC, WDG, WP	0.20 lb ai/A 0.0036 lb/gal			
Hazelnuts (Filberts)	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader, truck mounted fogger, backpack fogger	EC, WDG, WP	0.25 lb ai/A		0.75 lb ai/A	RTI = 10 days
		RTU (ULV)	0.007 lb ai/A			
Horseradish	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader, truck mounted fogger, backpack fogger	EC, WDG, WP	0.15 lb ai/A		0.45 lb ai/A	RTI = 10 days
		RTU (ULV)	0.007 lb ai/A			
Kiwi Fruit	Aerial, truck mounted fogger, non-thermal backpack fogger	RTU (ULV)	0.007 lb ai/A			
Lettuce	Aerial, chemigation, groundboom, mechanically pressurized handgun,	EC, WDG, WP	0.20 lb ai/A 0.0036 lbs ai/gal		0.8 lb ai/A	RTI = 7 days

Table 4.1. Summary of Directions for Food Uses of Permethrin.						
Crop/Use Site	Application Type and Equipment	Formulation	Maximum Application Rate	Max # App. per Season	Max. Seasonal Application Rate	Use Directions[1]
	tractor drawn spreader, truck mounted fogger, backpack fogger	RTU (ULV)	0.007 lb ai/A		(1.2 lb ai/A in HI)	
Melons (Bitter, Cantaloupe, Citron, Honeydew, Mango, Musk, Water, Winter)	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.2 lb ai/A 0.0036 lbs ai/gal		1.2 lb ai/A	RTI = 7 days
Mushrooms	Aerial, truck mounted fogger, non-thermal backpack fogger	EC, RTU (ULV)	0.007 lb ai/A			
Nectarines	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP (EC-ULV)	0.25 lb ai/A		0.75 lbs ai/A	
Onions	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.30 lb ai/A		1.0 lb ai/A	RTI = 7 days
		RTU (ULV)	0.007 lb ai/A			
Papaya	Aerial, airblast, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.15 lb ai/A		0.75 lb ai/A	RTI = 10 days
Peaches	Aerial, airblast, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.25 lb ai/A 0.0033 lbs ai/gal 0.0002 lb/12 floz		0.75 lb ai/A	RTI = 10 days
		RTU (ULV)	0.007 lb ai/A			
Pears: dormant & prebloom (combination)	Aerial, airblast, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.25 lb ai/A (0.4 lb ai/A dormant only) 0.0033 lbs ai/gal 0.0002 lb/12 fl oz		0.65 lb ai/A	RTI = 10 days
		RTU (ULV)	0.007 lb ai/A			
Pecan	Aerial, airblast, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC	0.20 lb ai/A 0.0033 lbs ai/gallon			
Peppers, bell	Aerial, airblast, chemigation, groundboom, mechanically	EC, WDG, WP	0.20 lb ai/A		0.8 lb ai/A	RTI = 5 days
		RTU (ULV)	0.007 lb ai/A			

Table 4.1. Summary of Directions for Food Uses of Permethrin.						
Crop/Use Site	Application Type and Equipment	Formulation	Maximum Application Rate	Max # App. per Season	Max. Seasonal Application Rate	Use Directions[1]
	pressurized handgun, tractor drawn spreader					
Pistachios	Aerial, airblast, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.3 lb ai/A		0.9 lb ai/A	RTI = 10 days
		RTU (ULV)	0.007 lb ai/A			
Potatoes	Aerial , chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.2 lb ai/A		0.8 lb ai/A	RTI = 10 days
		RTU (ULV)	0.007 lb ai/A			
Pumpkins	Aerial, chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.2 lb ai/A 0.0033 lbs ai/gal		1.2 lb ai/A	RTI = 7 days
Rangeland	Aerial, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.1 lb ai/A			
		RTU (ULV)	0.007 lb ai/A			
Raspberry (Black, Red)	Aerial, groundboom, mechanically pressurized handgun	EC	0.20 lb ai/A 0.0036 lbs ai/gal			
Soybeans	Aerial , chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.2 lb ai/A		0.4 lb ai/A	RTI = 10 days
		RTU (ULV)	0.007 lb ai/A			
Spinach, Orach (Mountain Spinach), spinach (New Zealand),	Aerial , chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.2 lb ai/A		0.6 lb ai/A	RTI = 3 days
		RTU (ULV)	0.007 lb ai/A			
Squash (summer, winter, spaghetti, butternut)	Aerial , chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.2 lb ai/A 0.0036 lbs ai/gal		1.2 lb ai/A	RTI = 7 days
Strawberry	Aerial , chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC	0.20 lb ai/A 0.0036 lb/gal			
Tomatoes, Tomatillo		EC, WDG, WP	0.2 lb ai/A 0.0036 lb /gal		0.6 lb ai/A	RTI = 7 days

Table 4.1. Summary of Directions for Food Uses of Permethrin.						
Crop/Use Site	Application Type and Equipment	Formulation	Maximum Application Rate	Max # App. per Season	Max. Seasonal Application Rate	Use Directions[1]
	Aerial , chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	RTU (ULV)	0.007 lb ai/A		(0.8 lb ai/A in HI)	
Turnip (greens and roots)	Aerial , chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	WDG, WP, EC	0.15 lb ai/A		0.45 lb ai/A	RTI = 3 days
Walnuts	Aerial , chemigation, groundboom, mechanically pressurized handgun, tractor drawn spreader	EC, WDG, WP	0.25 lb ai/A		0.75 lb ai/A	RTI = 10 days
		RTU (ULV)	0.007 lb ai/A			
Dry Bulk Fertilizer (Representative label: Permethrin EPA Reg. No.34704-873)						
Alfalfa, almonds, apples, artichoke, asparagus, avocado, broccoli, Brussel sprouts, cauliflower, cabbage, cantaloupes, celery, leafy vegetables, cherries, collards, conifers, corn (field, pop, sweet, seed), cucurbits, eggplants, filberts, horseradish, mushroom (houses), onions, garlic, ornamentals, papaya, peaches, nectarines, pears, peppers, pine seed orchards, pistachios, potatoes, pumpkins, range grass, soybeans, spinach, tomatoes, and walnuts	Impregnation	EC/L	0.3 lb ai/A 3.0 lb ai/ton			The listed crops corresponds to the crops listed on the agricultural labels. Apply using a minimum of 200 lbs dry bulk fertilizer/acre and a maximum of 450 lbs dry bulk fertilizer/acre Do not impregnate onto straight coated ammonium nitrate or straight limestone.
Seed Treatment (Representative label: Kernel Guard®/Vitavax® EPA Reg. No. 400-560)						
Corn (field, sweet, and pop)	scoop/tube	RTU	0.156 oz ai/ 42 lb seed			For application to corn (field, sweet, and pop) and soybeans. Do not bag or store excess treated seed beyond planting time. Do not use or mix treated seed with food or animal feed or process for oil. Do not mix with bare hands. PGI = 6 weeks
Soybeans			0.156 oz ai/ 50 lb seed			

Table 4.1. Summary of Directions for Food Uses of Permethrin.						
Crop/Use Site	Application Type and Equipment	Formulation	Maximum Application Rate	Max # App. per Season	Max. Seasonal Application Rate	Use Directions[1]
Residential Food Uses						
Residential Fruit and Nut Trees						
almond, filberts, pistachios	manually pressurized handwand, backpack	EC 53883-78	0.0036 lb ai/gal handler [29, 33][2]	5		Do not make more than 2 applications during hull split PHI = 7 days
pears				2-dormant 3-summer		PHI = 14 days
apples				3		Do not apply after petal fall
peaches				8		PHI = 7 days
Residential Gardens						
asparagus, broccoli, brussel sprouts, cabbage, cauliflower, celery, cherries, cucurbits, eggplant, horseradish, leafy vegetables, melons, potatoes, peppers, spinach, sweet corn, tomatoes	hose end sprayer	RTU	0.20 lb ai/gal handler [10][2]			[EPA Reg. Nos. 53883-134, 1021-2695]
	manually pressurized handwand, backpack	EC	0.02 ai/gal handler [29, 33][2]			
	shaker can, dust gun, puffer, rotary duster, bulbous duster	D	0.20 lb ai/A handler [2][2]	3-4 (4 in HI)	N/A	[EPA Reg. No. 1021-2724] RTI = 5-10 days PHI = 0-22 days Do not apply to tomatoes less than 1 inch in diameter Do not use a power duster

1 REI: 12 hours on all occupational use crops, (24 hours for EC formulations on EPA Reg. No. 53883-72)

2 The number in brackets after "handler" indicate the exposure scenario each residential handler use was assessed under in Table 5.1.1.

PPE- For liquids: All mixers, loaders, applicators, and other handlers must wear: baseline, gloves except for applicators using motorized ground equipment, pilots, and flaggers, chemical resistant aprons for mixer/loaders, cleaning equipment, and persons exposed to the concentrate and for handlers performing animal dip applications
For granular: All mixers, loaders, applicators, and other handlers must wear: baseline, gloves except for applicators using motorized ground equipment, pilots, and flaggers,
For Dust: All loaders, applicators, and other handlers must wear: baseline, gloves and a NIOSH respirator Application with aerial or motorized ground equipment is prohibited

Table 4.2. Non-Food and Non-Feed Use Patterns for Permethrin						
Crop/Use Site	Application Type and Equipment	Formulation	Handler/Post-app Exposure Scenario(s)[1]		Maximum Application Rate	Use Directions
			Residential[2]	Occupational		
Indoor uses[2]						
Animal Premises						
domestic animal premises [commercial and residential]	manually pressurized handwand	liquid	handler [28] post-app	handler	0.040 lb ai/gal	When used in dairy barns or facilities: Close milk bulk tank lids to prevent contamination. Indoor misting systems used in commercial barns, stables, and animal quarters: • Not for use in outdoor residential misting systems (indoor or outdoor). • Do not apply this product in barns or stables where animals intended for slaughter or human consumption will be maintained. • Do not apply when food, feed, or water is present. • Do not apply directly to animals. • When applying via a remote activation device, do not apply when people and pets are present. If possible, when applying via automatic timer, set the timing for application when people and pets are unlikely to be present. • Direct nozzles to spray towards the target area and away from areas where people are typically present. • Do not use in an evaporative cooling system. • Do not use in misters located within 3 feet of air vents, air conditioner units, or windows. • If used in a direct injection system, the pesticide container must be locked. Securely attach the end use label to the pesticide container in a weather protected area or plastic sleeve. (These instructions not applicable to wettable powder products). .
	aerosol can	PRL	handler [3] post-app	handler	0.000538 lb ai/16 oz can	
kennels/sleeping quarters [commercial and residential]	manually pressurized handwand, backpack	liquid	N/A	handler	0.78 lb ai/1000 sq ft	
	non-thermal fogger	EC			0.007 lb ai/acre	
barns, dairies, feedlots, livestock buildings, poultry houses, stables [commercial and residential]	manually pressurized handwand, backpack	EC, liquid	N/A	handler	0.04 lbs ai/gal 0.113 lb ai/1000 sq ft	
	compressed air-sprayer, non-thermal stationary fogger [based on EPA Reg. No. 47000-103 as a representative label]				Initial cleanout 0.50 oz ai/1000 cu ft [0.031 lb ai/1000 cu ft] Normal infestations 0. 25 oz ai/1000 cu ft [0.016 lb ai/1000 cu ft]	
Animals						
treated pets (dogs and cats)	dip	EC	handler [21] post-app		0.006 lb ai/gal	Do not use spot-on applications on cats. Use of handheld power duster equipment is prohibited.
	spot treatments (tube) **(not for use on cats)**	RTU (1 to 5 cc applicator tube)	handler [26] post-app		0.006 lb ai/animal	

Table 4.2. Non-Food and Non-Feed Use Patterns for Permethrin						
Crop/Use Site	Application Type and Equipment	Formulation	Handler/Post-app Exposure Scenario(s)[1]		Maximum Application Rate	Use Directions
			Residential[2]	Occupational		
	pour-on, trigger spray bottle	EC	handler [23] post-app		0.007 lb ai/animal [0.173 lb ai/gal spray]	
	shaker can [EPA Reg. No(s) 1021-1749, 28296-126, 28296-352]	D	handler [27] post-app		0.00016 lb ai/animal (0.0025 oz ai/animal) 70.85 mg ai/animal >20 lbs 45.43 mg ai/animal <20 lbs	
	rubber gloves (hands)/shampoo	RTU	handler [25] post-app		0.0014 lb ai/animal	
	aerosol/trigger spray bottle	PRL	handler [23, 24] post-app		0.000538 lb ai/16oz can	
dogs, horses	body wipe (towelette/sponge)	RTU	handler [22] post-app		0.0062 lb ai/animal	
horses	dust bag, dust glove, shaker can	D	handler [27]		0.000031 lb ai/animal	
	trigger spray bottle (body)	RTU	handler [23]		0.017 lb ai/animal	
	pour on, sponge	L	handler [22]		0.0062 lb ai/animal	
livestock (beef cattle, dairy cattle, goats, sheep)	ear tag	RTU	N/A		0.0044 lb ai/animal	
	dust bag, shaker can, mechanical duster	D			0.000031 lb ai/animal	
	pour-on (body)	RTU			0.0017 lb ai/animal	
	manually pressurized handwand, backpack, dip	L			0.0023 lb ai/animal	
poultry	dust bag	D			0.0025 lb ai/animal	
	high-pressure handwand	L			0.00027 lb ai/animal	
swine	shaker can, mechanical duster	D			0.00016 lb ai/animal	
	manually pressurized handwand, backpack, dip	L			0.002 lb ai/animal	
	cup, spreader	G			0.00156 lb ai/mound	
Engines						

Table 4.2. Non-Food and Non-Feed Use Patterns for Permethrin						
Crop/Use Site	Application Type and Equipment	Formulation	Handler/Post-app Exposure Scenario(s)[1]		Maximum Application Rate	Use Directions
			Residential[2]	Occupational		
vapor recovery systems	tube	RTU	N/A		0.000189 lb ai/tube	
Fabric						
personal clothing (shirt, pants, camping gear, bed net, etc.) [residential]	aerosol, spray bottle	RTU	handler [4, 8] post-app	N/A	0.002 lb ai/shirt, pants & bed net [0.0075 lb ai/24 oz bottle] [0.5% ai/canister]	From 2011 Table – Do not exceed an application rate equivalent to 1.25 grams of ai per square meter of fabric. All residential use liquid and RTU products labeled for surfaces must be formulated to no more than 0.5% ai.
military battle dress	dip, handgun, manually pressurized handwand, backpack, airblast	L	post-app	N/A	0.00000011 lb ai/cm^2 of fabric	
personal/military clothing		Impregnated material	post-app	NA	0.125 mg ai/cm^2	
Human bedding/mattresses: [residential and commercial]	trigger spray bottle, manually pressurized handwand	L	handler [28] post-app (HtM)		0.46 lb ai/1000 ft^2	
		EC			0.036 lb ai/gal	
Indoor Spaces						
indoor residential	fogger	RTU	post-app (HtM)		0.0023 lb ai/6 oz fogger (each oz fogger treats 1000 ft^3)	Do not use in aircraft cabins. Space spray or fog: Do not enter or allow others to enter until vapors, mists, and aerosols have dispersed and the treated area has been thoroughly ventilated. Total release foggers labeled for indoor use at residential sites must be formulated to contain no more than 0.58% permethrin. Note: If a higher concentration is proposed, the registrant must provide justification or data to demonstrate that an equivalent ISR of 5.6 ug.cm^2 or less will result in a room of 2000 ft^3 or less. For non-WPS use; stationary fogger- for 4 hours following applications, do not allow any persons to reenter treated areas. Total release fogger - Wait two (2) hours after application, then open windows, vents and doors for two hours. If an odor is still detected additional ventilation is required.
indoor commercial	fogger	RTU	N/A		0.035 lb ai/oz fogger (each oz fogger treats 1000 ft^3)	
	mechanical or compressed air equipment (non-thermal) fogger	RTU			0.00036 lb ai/1000 cu ft	

Table 4.2. Non-Food and Non-Feed Use Patterns for Permethrin						
Crop/Use Site	Application Type and Equipment	Formulation	Handler/Post-app Exposure Scenario(s)[1]		Maximum Application Rate	Use Directions
			Residential[2]	Occupational		
						Not for formulation into products for commercial indoor use applied with thermal or cold handheld foggers.
Indoor Surfaces						
eating establishments (non-food areas only), greenhouses, premises, refuse/solid waste sites, storage, warehouse space, wood [commercial, industrial and institutional]	crack and crevice, manually pressurized handwand, backpack	L	N/A		0.78 lb ai/1000 sq ft 0.037 lb ai/gal	Do not use in food areas of food handling establishments, restaurants, or other areas where food is commercially prepared or processed. Do not use in serving areas while food is exposed or facility is in operation. Serving areas are areas where prepared foods are served, such as dining rooms, but excluding areas where foods may be prepared or held. In the home, all food processing surfaces and utensils should be covered during treatment or thoroughly washed before use. Exposed food should be covered or removed. Do not apply when food is present. Do not apply as a broadcast treatment to indoor surfaces at residential sites, including nurseries, day care centers, schools, hospitals, and nursing homes. All residential use liquid and RTU products labeled for surfaces must be formulated to no more than 0.5% ai. Greater than 3% ai will be allowed when products are intended to be injected directly into crack and crevice if the registrant can provide justification will result in little to no exposure. Use of handheld power duster equipment is prohibited Do not enter or allow others to enter until sprays have dried and dusts have settled.
drainage systems [commercial, industrial, institutional, and residential]	manually pressurized handwand, backpack	EC, L			0.46 lb ai/1000 sq ft	
hospitals/medical institutions (human/veterinary)	crack and crevice	EC			0.025 lb ai/gal	
	manually pressurized handwand, backpack	L			0.46 lb ai/1000 sq ft	
households/domestic premises and contents [commercial, industrial, institutional, and residential]	aerosol can, hand pressure sprayer [spot-on/perimeter treatment]	PRL	handler [3, 7] post-app		0.00438 lb ai/16oz can	
	trigger, pump, or other type of sprayer [crack and crevice]	RTU	handler [7] post-app		0.043 lb ai/gal sprayer	
	hand trigger sprayer [spot-on/perimeter treatment]	EC	handler [7, 28] post-app		0.042 lb ai/gal	
	dust bag, shaker can, mechanical duster	D	handler [1] post-app	NA	0.01 lb ai/lb dust 1% ai (8oz product treats 100 sq ft)	
mushroom house premises	low-pressure handwand, fogger,	EC, WP	N/A		0.49 lb ai/A 0.267 lb ai/gal 0.0000018 lb ai/cu ft	Do not use high pressure handwands
Transportation						

Table 4.2. Non-Food and Non-Feed Use Patterns for Permethrin						
Crop/Use Site	Application Type and Equipment	Formulation	Handler/Post-app Exposure Scenario(s)[1]		Maximum Application Rate	Use Directions
			Residential[2]	Occupational		
Vehicles [Automobiles, taxis, limousines, recreational vehicles, and tires]	aerosol can, manually pressurized handwand	PRL	handler		0.000189 lb ai/tube	Do not use in aircraft cabins.
Military Aircraft (cabin, crew, and cargo areas) EPA Reg. No. 88144-1	Aerosol Can (100g product, 2% permethrin)	RTU (PL)	N/A	handler	0.00441 lb ai/can where one can treats 285m^3 [35 g product/100m^3]	Apply pre-flight – pre-embarkation. Do not spray directly on exposed food, food preparation areas or food utensils.
Outdoor Uses[3]						
Ants/Fire Ants						
Ant mound [spot treatment]	manually pressurized handwand, backpack	EC, L	handler [31, 34]		0.08 lb ai/mound	Do not water residential treated areas to the point of run-off. Do not make granular applications during rain.
	cup, spreader	G	handler [11, 14]		0.00156 lb ai/mound	
	impregnated coasters & covers	RTU	handler		none stated	
	impregnated gaskets for electrical wall plates, boxes, and plumbing flanges		N/A			
Christmas Tree Farm						
Christmas tree farm	foliar backpack, mechanically-pressurized handgun	DF, EC, L, WSP	N/A		0.2 lb ai/acre [DF, EC, L] 0.02 lb ai/tree [EC]	
Forest Trees						
Conifer pine seed orchard: foliar	aerial, airblast, backpack, chemigation, groundboom, manually pressurized handwand, mechanically pressurized handgun	EC, L	N/A		1.1 lb ai/acre 1.1 lb ai/100 gal 1.0 lb ai/tree	
		WDG, WP			1.6 lb ai/acre 1.6 lb ai/100 gal	
Forest trees (excluding pine seed orchards): foliar	aerial, backpack	EC, L			0.016 lbs ai/gal 0.6 lb ai/acre	Ground (low and high volume applications): Use 8-16 fuid oz of product/treated acre (0.2-0.4 lb ai/treated acre) using a final carrier solution of 25-400 gallons depending on the type of sprayer system being used. Make up to three applications per season.

Table 4.2. Non-Food and Non-Feed Use Patterns for Permethrin						
Crop/Use Site	Application Type and Equipment	Formulation	Handler/Post-app Exposure Scenario(s)[1]		Maximum Application Rate	Use Directions
			Residential[2]	Occupational		
						Air: Use 24 fluid oz of product/treated acre (0.6 lb ai/treated acre). Apply in a minimum of 5 gallons of finished spray per acre. Apply once per season.
Public Health Uses/Wide Area Uses						
outdoor/mosquitos	aerial, backpack, boom sprayer, mechanically pressurized handwand, truck mounted ULV fogger	EC, L	post-app		0.007 lb ai/acre	Do not retreat site more than once in 3 days. Do not exceed 25 applications per season (Max seasonal application rate = 0.18 lb ai/acre)
outdoor barrier spray/mosquitos	backpack ULV fogger	L (ULV)			0.007 lb ai/acre	
Ornamentals						
greenhouse [commercial and residential]	sprayer, sprinkler can	EC	handler [28]		0.0017 lb ai/gal (0.0032 lb ai/mound)	
greenhouse [commercial]	chemigation, mechanically pressurized handgun, groundboom	DF, WP	N/A		0.2 lb ai/acre	
indoor ornamentals [commercial, industrial, institutional, and residential]	manually pressurized handwand	L	handler [29, 33]		0.017 lb ai/gal	
		EC			0.041 lb ai/gal [1.03 lb ai/acre]	
indoor, outdoor [commercial, industrial, institutional, and residential]	aerosol can	PRL	handler [3, 5]		0.0025 lb ai/16oz can	
outdoor (trees, plants, shrubs, and vines) [commercial, industrial, institutional, and residential]	manually pressurized handwand, backpack	L, EC	handler [30, 32]		0.00078 lb ai/1000 sq ft 0.20 lb ai/A	
	shaker can, mechanical duster	D	handler [2]		0.0025 lb ai/1 lb container	Do not enter or allow others to enter the treated area until dusts have settled. If soil incorporation is required after the application, do not enter or allow others to enter the treated area (except those persons involved in the incorporation) until the incorporation is complete. If the incorporation is accomplished by watering-in, do not enter or allow others to enter the treated area until the surface is dry after the watering-in. Use of handheld power duster equipment is prohibited
	trigger, pump, or other type of sprayer	RTU	handler [9]		0.043 lb ai/gal sprayer	

Table 4.2. Non-Food and Non-Feed Use Patterns for Permethrin						
Crop/Use Site	Application Type and Equipment	Formulation	Handler/Post-app Exposure Scenario(s)[1]		Maximum Application Rate	Use Directions
			Residential[2]	Occupational		
Outdoor Spaces						
commercial, industrial, institutional, and residential	aerosol	RTU	handler [6] post-app		0.007 lb ai/acre [0.225% ai/16oz fogger]	Outdoor residential misting system use directions: • Do not use in an evaporative cooling system. • Direct nozzles to spray towards the target area and away from swimming pools, water bodies, or eating and cooking areas. • Do not set nozzles to direct mist near outside air condition systems or other home air intakes. • If used in a direct injection system, the pesticide container must be locked. Securely attach the end use label to the pesticide container in a weather protected area or plastic sleeve. (These instructions not applicable to wettable powder products). • If the system works on an automatic timer, set the timing for application when people, pets, and/or food are unlikely to be present. • If the system works when a person operates a remote activation device, then application of this pesticide when people, pets, and/or food are present is prohibited. • May only be used in systems that have been calibrated to apply no more than the maximum application rate of 0.25 grams per 1000 cubic feet per day.
automatic misting systems (including outdoor residential misting systems)	automatic misting system	L	post-app		0.25g ai/1000 ft^3/day (0.00055 lb ai/1000 ft^3/day) [0.0023 lb ai/gal with 55 and 250 gal drums]	
Outdoor Surfaces						
hedgerows, fencerows, equipment, outdoor premises, perimeter treatments, rights-of-ways (soil and vegetation)	manually pressurized handwand, backpack	EC, L	handler [31, 34]		0.78 lb ai/1000 sq ft	Do not enter or allow others to enter until sprays have dried. With the exception of outdoor fogging devices, all outdoor applications must be limited to spot or crack-and-crevice treatments only, except for the following permitted uses: (1) Treatment to soil or vegetation around structures; (2) Applications to lawns, turf, and other vegetation; (3) Applications to building foundations, up to a maximum height of 3 feet. Other than applications to building foundations, all outdoor applications to impervious surfaces such as sidewalks,
	aerosol can	PRL/RTU	handler [6]		0.035 lb ai/16oz can	
	crack and crevice, tube	RTU	handler [16]		0.0008 lb ai/1000 sq ft	
agricultural uncultivated areas	manually pressurized handwand, backpack	EC, L	handler [19]		0.213 lb ai/acre [0.04 lb ai/gal]	
refuse/solid waste sites [commercial, industrial, institutional, and residential]	paintbrush, manually pressurized handwand, backpack	L	N/A		0.04 lb ai/gal [0.85 lb ai/1000 sq ft]	

Table 4.2. Non-Food and Non-Feed Use Patterns for Permethrin						
Crop/Use Site	Application Type and Equipment	Formulation	Handler/Post-app Exposure Scenario(s)[1]		Maximum Application Rate	Use Directions
			Residential[2]	Occupational		
outdoor wood treatments (stored lumber/wood piles, pressure treatment, wood surfaces, and wood protection) [commercial, industrial, institutional, and residential]	paintbrush, roller, manually pressurized handwand, airless sprayer	EC, L	handler [17, 18, 19, 20] post-app		0.04 lb ai/gal [7.21 lb ai/acre] [0.081 mg ai/cm^2]	driveways, patios, porches and structural surfaces (such as windows, doors, and eaves) are limited to spot and crack- and crevice applications, only. Do not water residential treated areas to the point of run-off. Do not make granular applications during rain.
perimeter treatment (soil, vegetation, and lower buildings)	backpack, manually pressurized handwand	EC, L	handler [31, 34]		0.78 lb ai/gal	
perimeter treatment (soil and vegetation)	shaker can	G	handler [16]		0.0008 lb ai/ft^2 [0.8 lb ai/10 gallons treats 1000 sq ft]	
Termites						
termites: soil around underground utilities	handgun, backpack	EC	N/A		33.2 lb ai/1000 linear feet	The treatment site must be covered prior to a rain event in order to prevent runoff of the pesticide into non-target areas. Do not treat soil that is water-saturated or frozen. Do not treat when raining. Do not allow treatment to runoff from the target area. Do not apply within 10 feet of storm drains. Do not apply within 25 feet of aquatic habitats (such as, but not limited to, lakes; reservoirs; rivers; permanent streams; marshes or ponds; estuaries; and commercial fish farm ponds).
termites: soil surrounding standing wood	injector	EC			0.08 lb ai/gallon	
termites: soil, under concrete slabs, stoops, porches, structural voids,	foam application	RTU			4.25 lb ai/1000 sq ft	
Wood Treatment: trees, telephone poles, fence posts: nest opening	paintbrush, manually pressurized handwand, backpack	L			0.04 lb ai/gallon	
Turf						
turf [residential and commercial]	manually pressurized handwand, backpack	EC, L	handler [31, 34] post-app		0.87 lb ai/acre [0.04 lb ai/gal]	Do not water residential treated areas to the point of run-off. Do not make granular applications during rain.
	belly grinder, cup, hand dispersal, and spoon	G	handler [11 to 15] post-app		0.65 lb ai/acre [0.0003125 lb ai/mound] 5% permethrin	

Table 4.2. Non-Food and Non-Feed Use Patterns for Permethrin						
Crop/Use Site	Application Type and Equipment	Formulation	Handler/Post-app Exposure Scenario(s)[1]		Maximum Application Rate	Use Directions
			Residential[2]	Occupational		
	hose end sprayer	RTU	handler [10] post-app		0.45 lb ai/acre	
golf course turf	mechanically pressurized handgun, groundboom	EC	N/A		0.79 lb ai/acre	
commercial/industrial lawns	manually-pressurized handwand, mechanically pressurized handgun				0.87 lb ai/acre [0.04 lbs ai/gal]	

1 Handler exposure includes inhalation exposure only unless otherwise indicated. Post-application exposure include Hand to Mouth (HtM)/Object to Mouth (OtM) unless otherwise indicated.

2 The number in brackets after "handler" indicate the exposure scenario each residential handler use was assessed under in Table 5.1.1.

3 With the exception of outdoor fogging devices, all outdoor applications must be limited to spot or crack-and-crevice treatments only, except for the following permitted uses: Treatment to soil or vegetation around structures; Applications to lawns, turf, and other vegetation; Applications to building foundations, up to a maximum height of 3 feet.

APPENDIX B. Summary of AgDisp Results for Permethrin

Table B.1. AGDISP Inputs (v8.26): Permethrin Mosquitocide ULV Application		
	Inputs to include in the AgDISP model	**Notes/Comments[1]**
Application Method	Aerial	Default
Aircraft	Air Tractor AT-401	Default
Release Height	100 Feet minimum release	This information is found on the label.
Spray Lines	20 Reps	Default
Application Technique	Liquid	Default
Application Technique *Nozzles*	3; Extent 76.3%; Spacing 18.7 ft	Default
Application Technique *Drop Size Distribution*	User defined Parametric; $D_{V0.5}$: 60.09 µm; and relative span: 1.2. no conversion to Malvern Drop Size Distribution	The $D_{v0.5}$ and $D_{v0.9}$ value is from the chemical specific label (<60 µm and <115 µm respectively) and was incorporated into AgDISP v8.26 at the closest value possible to represent this range.
Swath Width	500 feet	Default
Swath Displacement	-32.47 feet	Default is typically 0 feet however, the spray deposition shows the peak deposition to be at a distance other than 0 feet, the swath displacement was therefore changed to the horizontal distance from the y axis where the peak deposition occurs.
Meteorology	Wind type: single height Wind speed: 10 mph Wind direction: -90 deg Temperature: 85 F° Relative humidity: 50%	This information is found on the labels
Spray Material	Name: water Spray Material Evaporates: Check spray volume rate: 0.0028 (gal/A) Active Fraction: 0.30 Nonvol Fraction:1	This information is found on the labels.
Atmospheric Stability	Overcast	Default
Surface	Upslope angle: 0 deg Sideslope angle: 0 deg Canopy: None	Default
Transport	Distance: 0 feet	Default
Advanced	Default Swatch offset: 0 Swath Specific Gravity carrier: Oil, Water, or undiluted specific gravity value Specific Gravity active and additive= X Evaporation Rate: 84.76	Default

Post-application Inhalation Exposure Algorithm for Truck Mounted ULV – Well Mixed Box Model

The following algorithm is used to determine post-application inhalation exposure to truck mounted fogger sprays:

$$\mathrm{TWA}\,(\mathrm{mg/m^3}) = \frac{\left[\frac{AR}{Q}\left(1 - e^{-\frac{Q}{V}(ET)}\right)\right]}{AT}$$

where:

[TWA] = time weighted average air concentration (mg/m^3);
AR = application rate (mg ai/day);
Q = airflow through the treated area (m^3/hour);
V = volume of the box (m^3)
ET = time (duration) of exposure (hours); and
AT = averaging time to match the duration of the HEC (hours).

Application rate for WMB analysis can be calculated as follows:

$$AR^* = AR * CF1^* CF2 * CF3$$

where:

AR* = application rate (mg ai/day)
AR = application rate (lb ai/A)
CF1 = unit conversion factor (454 g/lb)
CF2 = unit conversion factor (400ft^2/43560 ft2 per acre)
CF3 = unit conversion factor (1000mg/g)

The airflow through the treated space can be calculated as follows:

$$Q = AV * CF1^* CF2 * A_{cross\text{-}section}$$

where:

Q = airflow through treated space (m^3/hr);
AV = air velocity (m/s);
CF1 = time unit conversion factor (60 seconds/1 minute);
CF2 = time unit conversion factor (60 minutes / hour); and
$A_{cross\text{-}section}$ = cross-section of outdoor space treated (m^2).

Table D.8: Truck Mounted Mosquito Vector Control Fogger –Inputs for Residential Post-Application Inhalation Exposure		
Algorithm Notation	**Exposure Factor (units)**	**Point Estimate(s)**
AR	Application rate (lb ai/A)	0.007 lbs ai/acre
$A_{cross\text{-}section}$	Cross sectional area of area treated (m^2)	15
AV	Air velocity (m/s)	0.1
Q	Airflow through treated area (m^3/hr)	5,400
A.I.	Percent ai in product (%)	30%
V	Volume of the treated space (m^3)	90
ET	Exposure duration (hours) [equivalent to time spend outdoors on Turf]	1.5
AT	Averaging Time (hours) [equivalent to duration of inhalation toxicity study]	6

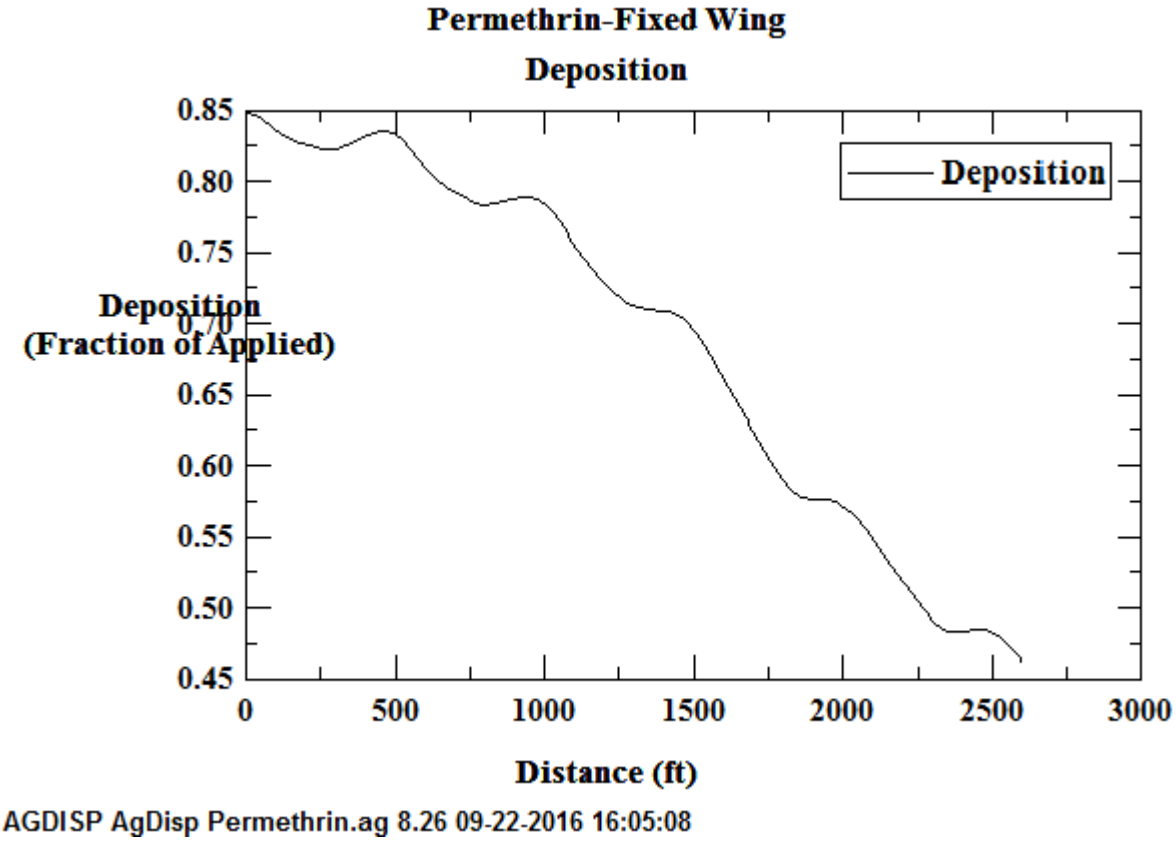

Figure 5.2.1. Estimated permethrin deposition downwind from the field edge from aerial treatment of mosquito adulticide at release height of 100 feet and swath displacement of -32.47 feet. Where the fraction of application rate for deposition was determined to be 0.85, the maximum fraction of 0.85 will be used for the deposition value.

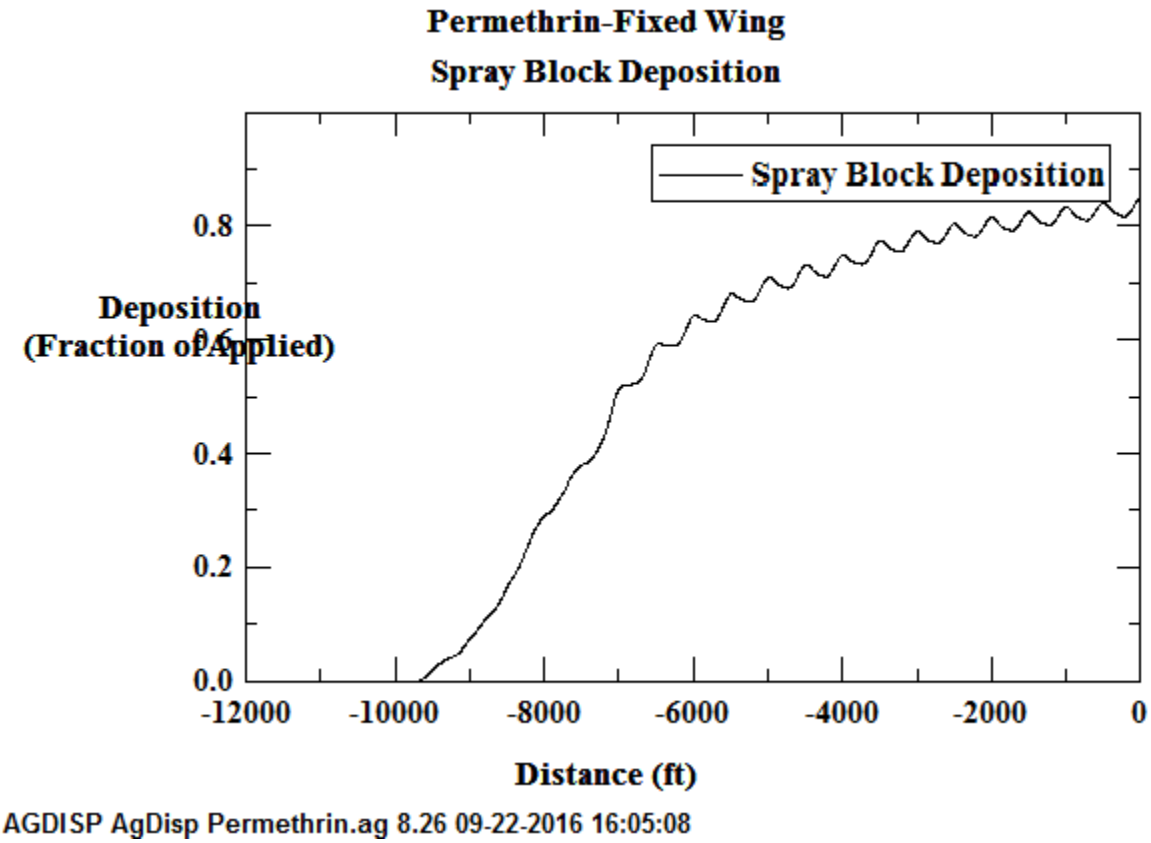

Figure 5.2.2. Provides an estimation of how permethrin deposition fluctuates over the spray block.

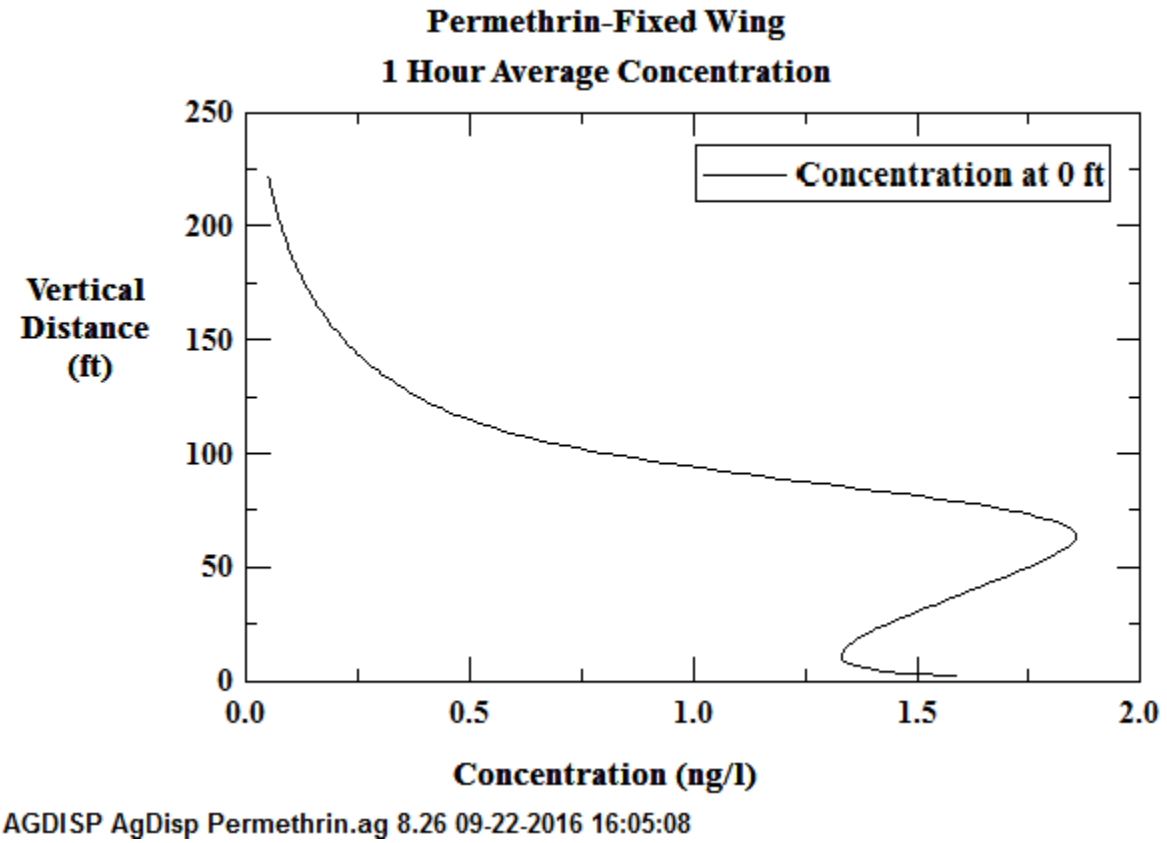

Figure 5.2.3. Estimated permethrin air concentration at the field edge from aerial treatment of mosquito adulticide at a release height of 100 feet and a swath displacement of -32.47 feet. 1.40 ng/L = 0.0014 mg/m^3 is the concentration at breathing height (5 feet*) for adults and children

*5-foot air concentration equals the average of the 1-hour air concentration between 4.45 ft (1.42ng/l) and 5.56 ft (1.38 ng/l).

0.0014 mg/ m^3 = 1.40 ng/L × (1 mg ÷ 1,000,000 ng) × (1000 L ÷ 1 m^3) = 0.0014 mg/ m^3

APPENDIX C. Details of Permethrin Air Monitoring Studies

- Lompoc, CA - Ambient Air Monitoring (2003) (CalDPR)
  http://www.cdpr.ca.gov/docs/specproj/lompoc/lompoc.htm
  - Ambient air monitoring of 22 pesticides and five oxygen analog breakdown products simultaneously during the peak use period for most of the pesticides, between May 31 and August 3, 2000.
  - DPR collected 24-hour samples, four consecutive days per week at each of four monitoring locations.
  - Four sampling sites were located within the city limits of Lompoc, one each in the northwest, central-west, southwest, and near the center of Lompoc. These sites plus an additional site on the northeast side of Lompoc were used.
  - Samplers at all locations were on rooftops to ensure the security of the samples.
  - DPR maintains a database of all agricultural pesticide applications in California, including date applied, amount applied, and application location.
  - For several individual pesticides (including permethrin), some non-monitored days during 2000 had two to four times more use than monitored days, which may indicate a higher air concentration and thus higher exposure to these six pesticides on those particular days.
  - Of the 31 pesticides or breakdown products monitored, DPR detected 27 of them in one or more of the 451 samples collected and analyzed.
    - Highest one-day air concentration for permethrin = (trace) 4.3 ng/m^3
    - Highest 14-day air concentration for permethrin = (trace) 1.23 ng/m^3
    - Highest 10-week air concentration for permethrin = (trace) 0.90 ng/m^3

- CA - Report for the Application (Butte County) and Ambient (Monterey County) Air Monitoring of Permethrin (1998)
  http://www.cdpr.ca.gov/docs/emon/pubs/tac/tacpdfs/permethr.pdf
  - Application monitoring was conducted in Butte County around the use of permethrin on 10 acres of walnuts from July 31 to August 4, 1997.
    - Permethrin was applied at a rate of 0.39 lb ai/acre with a spray/blower.
    - Samples were collected from 4 samplers on each side of the field at; 1 hour, 2 hours, 4 hours, 8 hours, and 24 hours after application.
    - All 3 application background samples were detected. Of the 24-hour application samples collected, 3 were above the level of quantification (LOQ = 0.33 ng/m^3).
      - Highest application concentration for permethrin = 0.57 ng/m^3
  - Ambient air monitoring was conducted in Monterey County to coincide with the use of permethrin on lettuce and celery from August 12 to September 19, 1997.
    - A total of 24 discreet sampling days (4 samples/week) were monitored at five public building sites for a total of 115 samples.
    - Samplers at all locations were on rooftops to ensure the security of the samples.
    - Of the 115 ambient air samples DPR collected, 6 were detected with the

remaining 109 less than the level of detection.

- Parlier, CA - Ambient Air Monitoring 2009 (CDPR and CARB) http://www.cdpr.ca.gov/docs/envjust/pilot_proj/parlier_final.pdf
    - Collected ambient air samples over 12 months from January 3- December 28, 2006
    - Sampling stations were positioned at three elementary schools in Parlier
    - Of the potentially 468 samples, permethrin levels were quantifiable in 1 sample, however 0 samples were above the level of quantification (LOQ = 46.3).
        - Highest one-day air concentration for permethrin = (trace) 26.8 ng/m^3
        - Highest 14-day air concentration for permethrin = 7.47 ng/m^3
        - One year average air concentration for permethrin = 3.76 ng/m^3

- CDPR Air Monitoring Network (AMN) program – 2011-2015 (CDPR) http://www.cdpr.ca.gov/docs/emon/airinit/air_network_results.htm
    - CDPR has established a monitoring network to sample ambient air for multiple pesticides in three communities on a regular schedule
        - Ripon (San Joaquin County, approximately 20 miles south of Stockton)
        - Salinas (Monterey County, approximately 60 miles south of San Jose)
        - Shafter (Kern County, approximately 20 miles northwest of Bakersfield)
    - CDPR designed the study to collect one 24-hour sample each week over a multiple year sampling duration.
    - Data from years 2011 through 2015 is provided.
    - AMN analyzed data for permethrin at the Salinas, Shafter, and Ripon locations, all 24-hour samples were found to be trace or non-detect (LOD = 7.2 ng/m^3, LOQ = 23.1 ng/m^3).

APPENDIX D. REJV Survey Search Criteria and Annual Frequency Calculations

Table D.1. REJV Survey Search Criteria and Annual Frequency Calculations[1]						
Exposure Scenario	**Coding used in Cares NG REJV Database**	**Frequency (Applications)**	**Number of Households**	**Freq. × # of HH**	**%**	**% Total**
1. Indoor Perimeter/Spot/ Bedbug; Crack and Crevice Application with Bulb Duster	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and pformx = "dust" and (sdinrmx="1" or sbeddingx="1" or sbedrmx="1" or slivrmx="1" or ssunrmx="1" or sofficex="1" or sfamrmx="1" or splayx="1" or skitchx="1" or sutlrmx="1" or sbathx="1" or sporchx="1" or satticx="1" or sgaragex="1" or sgarageuax="1" or subasx="1" or scarpetx="1" or scupbrdsx="1" or soinareax="1") and (tspotx="1" or tinccx="1" or tinperimx="1") GROUP BY hhidx	1	34	34	54.8387	54.8387
		2	11	22	17.7419	72.5806
		3	7	21	11.2903	83.8709
		4	3	12	4.8387	88.7096
		5	1	5	1.6129	90.3225
		7	1	7	1.6129	91.9354
		8	1	8	1.6129	93.5483
		14	**1**	**14**	**1.6129**	**95.1612**
		17	1	17	1.6129	96.7741
		18	1	18	1.6129	98.387
		30	**1**	**30**	**1.6129**	**99.9999**
	Average = 3.032258	**Total**	**62**	**188**		
2. Outdoor Garden/Tree (Ornamental) Dust Application with Shaker Can	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and pformx = "dust" and (sornamx="1" or sflowerx="1" or sshrubx="1" or svegx="1" or streex="1" or sotreex="1") and (tspotx="1" or tbroadx="1" or toutairx="1") GROUP BY hhidx	1	72	72	40.678	40.678
		2	41	82	23.1638	63.8418
		3	19	57	10.7345	74.5763
		4	11	44	6.2147	80.791
		5	9	45	5.0847	85.8757
		6	4	24	2.2599	88.1356
		7	7	49	3.9548	92.0904
		8	2	16	1.1299	93.2203
		9	**4**	**36**	**2.2599**	**95.4802**
		10	2	20	1.1299	96.6101
		11	1	11	0.565	97.1751
		13	1	13	0.565	97.7401
		14	2	28	1.1299	98.87
		15	1	15	0.565	99.435
		18	**1**	**18**	**0.565**	**100**
	Average = 2.99435	**Total**	**177**	**530**		
27. Direct Application to Dogs/Horses with Shaker Can	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and pformx = "dust" and (sdogx="1" or shorsex="1") GROUP BY hhidx	1	10	10	47.619	47.619
		2	7	14	33.3333	80.9523
		3	1	3	4.7619	85.7142
		4	1	4	4.7619	90.4761
		6	**2**	**12**	**9.5238**	**99.9999**
	Average = 2.047619	**Total**	**21**	**43**		
Ready to Use Solution						
3. Indoor Perimeter/ Spot/ Bedbug (course application) with Aerosol Can	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and maerosolx="1" and (sdinrmx="1" or sbeddingx="1" or sbedrmx="1" or slivrmx="1" or ssunrmx="1" or sofficex="1" or sfamrmx="1" or splayx="1" or	1	332	332	29.1484	29.1484
		2	201	402	17.6471	46.7955
		3	129	387	11.3257	58.1212
		4	93	372	8.1651	66.2863
		5	60	300	5.2678	71.5541

Table D.1. REJV Survey Search Criteria and Annual Frequency Calculations[1]						
Exposure Scenario	**Coding used in Cares NG REJV Database**	**Frequency (Applications)**	**Number of Households**	**Freq. × # of HH**	**%**	**% Total**
	skitchx="1" or sutlrmx="1" or sbathx="1" or sporchx="1" or satticx="1" or sgaragex="1" or sgarageuax="1" or subasx="1" or scarpetx="1" or scupbrdsx="1" or soinareax="1") and (tspotx="1" or tinccx="1" or tinperimx="1") GROUP BY hhidx	6	40	240	3.5119	75.066
		7	34	238	2.9851	78.0511
		8	31	248	2.7217	80.7728
		9	27	243	2.3705	83.1433
		10	28	280	2.4583	85.6016
		11	12	132	1.0536	86.6552
		12	15	180	1.3169	87.9721
		13	20	260	1.7559	89.728
		14	15	210	1.3169	91.0449
		15	10	150	0.878	91.9229
		16	9	144	0.7902	92.7131
		17	6	102	0.5268	93.2399
		18	6	108	0.5268	93.7667
		19	4	76	0.3512	94.1179
		20	6	120	0.5268	94.6447
		21	**4**	**84**	**0.3512**	**94.9959**
		22	5	110	0.439	95.4349
		23	4	92	0.3512	95.7861
		24	5	120	0.439	96.2251
		25	4	100	0.3512	96.5763
		26	2	52	0.1756	96.7519
		27	3	81	0.2634	97.0153
		28	1	28	0.0878	97.1031
		30	2	60	0.1756	97.2787
		31	1	31	0.0878	97.3665
		32	3	96	0.2634	97.6299
		34	2	68	0.1756	97.8055
		35	3	105	0.2634	98.0689
		36	1	36	0.0878	98.1567
		38	2	76	0.1756	98.3323
		46	1	46	0.0878	98.4201
		47	1	47	0.0878	98.5079
		48	1	48	0.0878	98.5957
		54	3	162	0.2634	98.8591
		55	1	55	0.0878	98.9469
		57	1	57	0.0878	99.0347
		58	1	58	0.0878	99.1225
		72	1	72	0.0878	99.2103
		73	1	73	0.0878	99.2981
		77	1	77	0.0878	99.3859
		88	1	88	0.0878	99.4737
		103	1	103	0.0878	99.5615

Table D.1. REJV Survey Search Criteria and Annual Frequency Calculations[1]						
Exposure Scenario	**Coding used in Cares NG REJV Database**	**Frequency (Applications)**	**Number of Households**	**Freq. × # of HH**	**%**	**% Total**
		116	1	116	0.0878	99.6493
		124	1	124	0.0878	99.7371
		152	1	152	0.0878	99.8249
		154	1	154	0.0878	99.9127
		259	1	259	0.0878	100.0005
	Average = 6.456540825	**Totals**	**1139**	**7354**		
4. Fabric Directed Spray (insect repellent) Spot/Bedbug Application with Aerosol Can **8. Fabric Directed Spray (insect repellent) Spot/Bedbug Application with Trigger-Spray Bottle**	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (maerosolx="1" or mspritzx="1" or mshandtrigx="1") and (tfurniturex="1" or mclothingx="1") GROUP BY hhidx	1	93	93	48.9474	48.9474
		2	38	76	20	68.9474
		3	18	54	9.4737	78.4211
		4	11	44	5.7895	84.2106
		5	8	40	4.2105	88.4211
		6	3	18	1.5789	90
		7	4	28	2.1053	92.1053
		8	2	16	1.0526	93.1579
		9	1	9	0.5263	93.6842
		10	**2**	**20**	**1.0526**	**94.7368**
		11	1	11	0.5263	95.2631
		13	2	26	1.0526	96.3157
		16	1	16	0.5263	96.842
		17	1	17	0.5263	97.3683
		27	1	27	0.5263	97.8946
		28	2	56	1.0526	98.9472
		32	1	32	0.5263	99.4735
		39	1	39	0.5263	99.9998
	Average = 2.711765	**Totals**	**190**	**622**		
5. Outdoor Garden/Tree (Ornamental) Application with Aerosol Can **9. Outdoor Garden/Tree (Ornamental) Application with Trigger-Spray Bottle**	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (maerosolx="1" or mspritzx="1" or mshandtrigx="1") and (sornamx="1" or sflowerx="1" or sshrubx="1" or svegx="1" or streex="1" or sotreex="1") GROUP BY hhidx	1	288	288	47.3684	47.3684
		2	105	210	17.2697	64.6381
		3	76	228	12.5	77.1381
		4	41	164	6.7434	83.8815
		5	25	125	4.1118	87.9933
		6	19	114	3.125	91.1183
		7	10	70	1.6447	92.763
		8	10	80	1.6447	94.4077
		9	**7**	**63**	**1.1513**	**95.559**
		10	5	50	0.8224	96.3814
		11	8	88	1.3158	97.6972
		12	3	36	0.4934	98.1906
		13	1	13	0.1645	98.3551
		14	2	28	0.3289	98.684
		15	1	15	0.1645	98.8485
		16	1	16	0.1645	99.013
		18	2	36	0.3289	99.3419

Table D.1. REJV Survey Search Criteria and Annual Frequency Calculations[1]						
Exposure Scenario	**Coding used in Cares NG REJV Database**	**Frequency (Applications)**	**Number of Households**	**Freq. × # of HH**	**%**	**% Total**
		19	1	19	0.1645	99.5064
		20	1	20	0.1645	99.6709
		27	1	27	0.1645	99.8354
		32	1	32	0.1645	99.9999
	Average = 2.832237	**Totals**	**608**	**1722**		
6. Outdoor Space/Perimeter Treatment with Aerosol Can	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and pformx = "ready-to-use solution" and maerosolx="1" and (tspotx="1" or toutfndx="1" or toutccx="1") GROUP BY hhidx	1	50	50	60.241	60.241
		2	13	26	15.6627	75.9037
		3	7	21	8.4337	84.3374
		4	1	4	1.2048	85.5422
		5	5	25	6.0241	91.5663
		6	2	12	2.4096	93.9759
		7	**3**	**21**	**3.6145**	**97.5904**
		8	1	8	1.2048	98.7952
		10	**1**	**10**	**1.2048**	**100**
	Average = 2.13253	**Totals**	**83**	**177**		
7. Indoor Perimeter/ Spot/ Bedbug (course application) with Trigger-Spray Bottle	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (mspritzx="1" or mshandtrigx="1") and (sdinrmx="1" or sbeddingx="1" or sbedrmx="1" or slivrmx="1" or ssunrmx="1" or sofficex="1" or sfamrmx="1" or splayx="1" or skitchx="1" or sutlrmx="1" or sbathx="1" or sporchx="1" or satticx="1" or sgaragex="1" or sgarageuax="1" or subasx="1" or scarpetx="1" or scupbrdsx="1" or soinareax="1") and (tspotx="1" or tinccx="1" or tinperimx="1") GROUP BY hhidx	1	309	309	42.6796	42.6796
		2	**131**	**262**	**18.0939**	**60.7735**
		3	65	195	8.9779	69.7514
		4	69	276	9.5304	79.2818
		5	37	185	5.1105	84.3923
		6	30	180	4.1436	88.5359
		7	17	119	2.3481	90.884
		8	10	80	1.3812	92.2652
		9	9	81	1.2431	93.5083
		10	7	70	0.9669	94.4752
		11	**4**	**44**	**0.5525**	**95.0277**
		12	2	24	0.2762	95.3039
		13	4	52	0.5525	95.8564
		14	4	56	0.5525	96.4089
		15	1	15	0.1381	96.547
		16	3	48	0.4144	96.9614
		17	2	34	0.2762	97.2376
		18	2	36	0.2762	97.5138
		19	1	19	0.1381	97.6519
		20	1	20	0.1381	97.79
		21	2	42	0.2762	98.0662
		22	1	22	0.1381	98.2043
		23	1	23	0.1381	98.3424
		24	2	48	0.2762	98.6186
		25	1	25	0.1381	98.7567
		26	2	52	0.2762	99.0329
		29	1	29	0.1381	99.171

Table D.1. REJV Survey Search Criteria and Annual Frequency Calculations[1]						
Exposure Scenario	**Coding used in Cares NG REJV Database**	**Frequency (Applications)**	**Number of Households**	**Freq. × # of HH**	**%**	**% Total**
		39	1	39	0.1381	99.3091
		42	1	42	0.1381	99.4472
		54	1	54	0.1381	99.5853
		58	1	58	0.1381	99.7234
		67	1	67	0.1381	99.8615
		107	1	107	0.1381	99.9996
	Average = 3.747237569	**Totals**	**724**	**2713**		
10. Outdoor Lawn/Turf Treatment with Hose-end Sprayer	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and mshoseendx="1" and (salllawnx="1" or sspotlawnx="1") and (pformx REGEXP 'concentrate|solution|pressurized|powder') GROUP BY hhidx	1	176	176	51.1628	51.1628
		2	85	170	24.7093	75.8721
		3	31	93	9.0116	84.8837
		4	21	84	6.1047	90.9884
		5	**13**	**65**	**3.7791**	**94.7675**
		6	3	18	0.8721	95.6396
		7	4	28	1.1628	96.8024
		8	1	8	0.2907	97.0931
		9	2	18	0.5814	97.6745
		14	1	14	0.2907	97.9652
		16	2	32	0.5814	98.5466
		18	1	18	0.2907	98.8373
		20	1	20	0.2907	99.128
		21	1	21	0.2907	99.4187
		40	1	40	0.2907	99.7094
		65	**1**	**65**	**0.2907**	**100.0001**
	Average = 2.52907	**Totals**	**344**	**870**		
23. Direct Application to Dogs/Horses with Trigger-Spray Bottle	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (sdogx="1" AND mspritzx="1" AND (pformx != "dust" OR pformx IS NULL)) OR (sdogx="1" AND mshandtrigx="1") OR (skennelx="1" AND mspritzx="1" AND tdirectx="1") OR (sdogx="1" AND mpotherx="1" AND pformx="ready-to-use solution" AND (pnamex NOT REGEXP 'shampoo|ear|heart|pill|tabs|tablets|spot|squeeze|drop|dip|sponge' OR pnamex IS NULL) AND (pnamenewx NOT REGEXP 'shampoo|ear|heart|pill|tabs|tablets|spot|squeeze|drop|dip|sponge' OR pnamenewx IS NULL)) OR (sdogx="1" AND mpotherx="1" AND pformx="pressurized liquid" AND (pnamex NOT REGEXP 'shampoo|ear|heart|pill|tabs|tablets|spot|squeeze|drop|dip|sponge' OR pnamex IS NULL) AND (pnamenewx NOT REGEXP 'shampoo|ear|heart|pill|tabs|tablets|spot|squeeze|drop|dip|sponge' OR pnamenewx IS NULL)) OR (sdogx="1" AND mspotx="1" AND (pnamex	1	88	88	46.0733	46.0733
		2	36	72	18.8482	64.9215
		3	10	30	5.2356	70.1571
		4	9	36	4.712	74.8691
		5	12	60	6.2827	81.1518
		6	4	24	2.0942	83.246
		7	3	21	1.5707	84.8167
		9	3	27	1.5707	86.3874
		10	3	30	1.5707	87.9581
		11	1	11	0.5236	88.4817
		12	2	24	1.0471	89.5288
		13	3	39	1.5707	91.0995
		14	1	14	0.5236	91.6231
		15	2	30	1.0471	92.6702
		18	1	18	0.5236	93.1938
		22	1	22	0.5236	93.7174
		24	1	24	0.5236	94.241
		26	1	26	0.5236	94.7646

Table D.1. REJV Survey Search Criteria and Annual Frequency Calculations[1]						
Exposure Scenario	**Coding used in Cares NG REJV Database**	**Frequency (Applications)**	**Number of Households**	**Freq. × # of HH**	**%**	**% Total**
	REGEXP 'spray|mist' OR pnamenewx REGEXP 'spray|mist')) or (shorsex="1" AND mspritzx="1" AND (pformx != "dust" OR pformx IS NULL)) OR (shorsex="1" AND mshandtrigx="1") OR (shorsex="1" AND mpotherx="1" AND pformx="ready-to-use solution" AND (pnamex NOT REGEXP 'shampoo|ear|heart|pill|tabs|tablets|spot|squeeze|drop|dip|sponge' OR pnamex IS NULL) AND (pnamenewx NOT REGEXP 'shampoo|ear|heart|pill|tabs|tablets|spot|squeeze|drop|dip|sponge' OR pnamenewx IS NULL)) OR (shorsex="1" AND mpotherx="1" AND pformx="pressurized liquid" AND (pnamex NOT REGEXP 'shampoo|ear|heart|pill|tabs|tablets|spot|squeeze|drop|dip|sponge' OR pnamex IS NULL) AND (pnamenewx NOT REGEXP 'shampoo|ear|heart|pill|tabs|tablets|spot|squeeze|drop|dip|sponge' OR pnamenewx IS NULL)) OR (shorsex="1" AND mspotx="1" AND (pnamex REGEXP 'spray|mist' OR pnamenewx REGEXP 'spray|mist')) GROUP BY hhidx	**28**	**1**	**28**	**0.5236**	**95.2882**
		29	1	29	0.5236	95.8118
		36	1	36	0.5236	96.3354
		38	1	38	0.5236	96.859
		42	1	42	0.5236	97.3826
		43	1	43	0.5236	97.9062
		45	1	45	0.5236	98.4298
		57	1	57	0.5236	98.9534
		79	1	79	0.5236	99.477
		170	1	170	0.5236	100.0006
	Average = 6.089005236	**Totals**	**191**	**1163**		
24. Direct Application to Dogs and Cats with Aerosol Can	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (sdogx="1" AND maerosolx="1") OR (skennelx="1" AND maerosolx="1" AND tdirectx="1") OR (sdogx="1" AND mpotherx="1" AND pformx="pressurized liquid" AND (pnamex NOT REGEXP 'shampoo|ear|heart|pill|tabs|tablets|spot|squeeze|drop' OR pnamenewx NOT REGEXP 'shampoo|ear|heart|pill|tabs|tablets|spot|squeeze|drop'))OR (sdogx="1" AND mspotx="1" AND (pnamex REGEXP 'spray|mist' OR pnamenewx REGEXP 'spray|mist')) or (scatx="1" AND maerosolx="1") OR (skennelx="1" AND maerosolx="1" AND tdirectx="1") OR (scatx="1" AND mpotherx="1" AND pformx="pressurized liquid" AND (pnamex NOT REGEXP 'shampoo|ear|heart|pill|tabs|tablets|spot|squeeze|drop' OR pnamenewx NOT REGEXP 'shampoo|ear|heart|pill|tabs|tablets|spot|squeeze|drop')) OR (scatx="1" AND mspotx="1" AND (pnamex REGEXP 'spray|mist' OR pnamenewx REGEXP 'spray|mist')) GROUP BY hhidx	**1**	**36**	**36**	**46.1538**	**46.1538**
		2	16	32	20.5128	66.6666
		3	5	15	6.4103	73.0769
		4	8	32	10.2564	83.3333
		5	2	10	2.5641	85.8974
		6	1	6	1.2821	87.1795
		7	2	14	2.5641	89.7436
		8	3	24	3.8462	93.5898
		9	**1**	**9**	**1.2821**	**94.8719**
		10	1	10	1.2821	96.154
		11	1	11	1.2821	97.4361
		14	1	14	1.2821	98.7182
		24	1	24	1.2821	100.0003
	Average = 3.038461538	**Totals**	**78**	**237**		
25. Direct Application to Dogs with RTU via Hand/Glove (Shampoo	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (sdogx="1" AND mshampx="1") OR (sdogx="1" AND mshampx IS NULL AND (pnamex REGEXP 'shampoo' OR pnamenewx REGEXP 'shampoo')) GROUP BY hhidx	1	34	34	37.7778	37.7778
		2	16	32	17.7778	55.5556
		3	8	24	8.8889	64.4445
		4	8	32	8.8889	73.3334
		5	2	10	2.2222	75.5556
		6	6	36	6.6667	82.2223
		7	4	28	4.4444	86.6667

Table D.1. REJV Survey Search Criteria and Annual Frequency Calculations[1]						
Exposure Scenario	**Coding used in Cares NG REJV Database**	**Frequency (Applications)**	**Number of Households**	**Freq. × # of HH**	**%**	**% Total**
		10	1	10	1.1111	87.7778
		13	3	39	3.3333	91.1111
		14	1	14	1.1111	92.2222
		15	1	15	1.1111	93.3333
		16	1	16	1.1111	94.4444
		17	**1**	**17**	**1.1111**	**95.5555**
		19	1	19	1.1111	96.6666
		27	1	27	1.1111	97.7777
		51	1	51	1.1111	98.8888
		56	1	56	1.1111	99.9999
	Average = 5.111111	**Totals**	**90**	**460**		
26. Direct Spot-On Treatment to Dogs with RTU Applicator Tube	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (sdogx="1" AND mspotx="1" AND (pformx<>'Dust' OR pformx IS NULL) AND (pnamex NOT REGEXP 'shampoo|spray|mist|ear|heart|pill|tabs|tablets|dip|sponge' OR pnamex IS NULL) AND (pnamenewx NOT REGEXP 'shampoo|spray|mist|ear|heart|pill|tabs|tablets|dip|sponge' OR pnamenewx IS NULL)) OR (sdogx="1" AND mpotherx="1" AND pformx="ready-to-use solution" AND (pnamex NOT REGEXP 'shampoo|spray|mist|ear|heart|pill|tabs|tablets|dip|sponge' OR pnamex IS NULL) AND (pnamenewx NOT REGEXP 'shampoo|spray|mist|ear|heart|pill|tabs|tablets|dip|sponge' OR pnamenewx IS NULL)) OR (sdogx="1" AND mdpourx="1" AND pformx="ready-to-use solution" AND (pnamex NOT REGEXP 'shampoo|spray|mist|ear|heart|pill|tabs|tablets|dip|sponge' OR pnamex IS NULL) AND (pnamenewx NOT REGEXP 'shampoo|spray|mist|ear|heart|pill|tabs|tablets|dip|sponge' OR pnamenewx IS NULL)) OR (skennelx="1" AND mspotx="1" AND tdirectx="1" AND pformx="ready-to-use solution" AND (pnamex NOT REGEXP 'shampoo|spray|mist|ear|heart|pill|tabs|tablets|dip|sponge' OR pnamex IS NULL) AND (pnamenewx NOT REGEXP 'shampoo|spray|mist|ear|heart|pill|tabs|tablets|dip|sponge' OR pnamenewx IS NULL)) GROUP BY hhidx	1	121	121	23.1801	23.1801
		2	84	168	16.092	39.2721
		3	49	147	9.387	48.6591
		4	41	164	7.8544	56.5135
		5	36	180	6.8966	63.4101
		6	29	174	5.5556	68.9657
		7	17	119	3.2567	72.2224
		8	25	200	4.7893	77.0117
		9	26	234	4.9808	81.9925
		10	14	140	2.682	84.6745
		11	19	209	3.6398	88.3143
		12	20	240	3.8314	92.1457
		13	6	78	1.1494	93.2951
		14	5	70	0.9579	94.253
		15	**5**	**75**	**0.9579**	**95.2109**
		16	3	48	0.5747	95.7856
		18	2	36	0.3831	96.1687
		19	1	19	0.1916	96.3603
		20	3	60	0.5747	96.935
		21	1	21	0.1916	97.1266
		22	7	154	1.341	98.4676
		23	1	23	0.1916	98.6592
		24	3	72	0.5747	99.2339
		25	1	25	0.1916	99.4255
		28	1	28	0.1916	99.6171
		30	1	30	0.1916	99.8087
		32	1	32	0.1916	100.0003
	Average = 5.492337165	**Totals**	**522**	**2867**		
Other: Indoor Fogger	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and	1	57	57	53.7736	53.7736
		2	24	48	22.6415	76.4151
		3	14	42	13.2075	89.6226

Table D.1. REJV Survey Search Criteria and Annual Frequency Calculations[1]						
Exposure Scenario	**Coding used in Cares NG REJV Database**	**Frequency (Applications)**	**Number of Households**	**Freq. × # of HH**	**%**	**% Total**
	mfoggerx="1" and (sdinrmx="1" or sbeddingx="1" or sbedrmx="1" or slivrmx="1" or ssunrmx="1" or sofficex="1" or sfamrmx="1" or splayx="1" or skitchx="1" or sutlrmx="1" or sbathx="1" or sporchx="1" or satticx="1" or sgaragex="1" or sgarageuax="1" or subasx="1" or scarpetx="1" or scupbrdsx="1" or soinareax="1") and (tbroadx="1" or tinairx="1") GROUP BY hhidx	4	3	12	2.8302	92.4528
		5	**3**	**15**	**2.8302**	**95.283**
		6	1	6	0.9434	96.2264
		7	1	7	0.9434	97.1698
		8	1	8	0.9434	98.1132
		12	1	12	0.9434	99.0566
		16	1	16	0.9434	100
	Average = 2.015625	**Totals**	**106**	**223**		
Other: Outdoor Aerosol Space Spray	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (maerosolx="1" or mspritzx="1" or mshandtrigx="1") and (salllawnx="1" or sspotlawnx="1" or sairoutx="1") and (toutairx="1") GROUP BY hhidx	1	157	157	55.8719	55.8719
		2	62	124	22.0641	77.936
		3	23	69	8.1851	86.1211
		4	12	48	4.2705	90.3916
		5	10	50	3.5587	93.9503
		6	**2**	**12**	**0.7117**	**94.662**
		7	2	14	0.7117	95.3737
		8	3	24	1.0676	96.4413
		9	2	18	0.7117	97.153
		10	3	30	1.0676	98.2206
		11	1	11	0.3559	98.5765
		17	1	17	0.3559	98.9324
		36	2	72	0.7117	99.6441
		76	1	76	0.3559	100
	Average= 2.569395018	**Totals**	**281**	**722**		
Other: Mattress	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and sbeddingx="1" GROUP BY hhidx	1	45	45	48.913	48.913
		2	22	44	23.913	72.826
		3	7	21	7.6087	80.4347
		4	5	20	5.4348	85.8695
		5	2	10	2.1739	88.0434
		6	2	12	2.1739	90.2173
		7	1	7	1.087	91.3043
		8	1	8	1.087	92.3913
		12	1	12	1.087	93.4783
		20	**1**	**20**	**1.087**	**94.5653**
		23	1	23	1.087	95.6523
		25	1	25	1.087	96.7393
		27	1	27	1.087	97.8263
		31	1	31	1.087	98.9133
		32	1	32	1.087	100.0003
	Average= 3.663043478	**Totals**	**92**	**337**		
Granular						
11. Outdoor Lawn/Turf	SELECT hhidx, count(*) as total FROM application_update	1	167	167	53.0159	53.0159
		2	76	152	24.127	77.1429

Table D.1. REJV Survey Search Criteria and Annual Frequency Calculations[1]						
Exposure Scenario	**Coding used in Cares NG REJV Database**	**Frequency (Applications)**	**Number of Households**	**Freq. × # of HH**	**%**	**% Total**
Treatment with Push-type Rotary Spreader	WHERE allyrx="1" and usablex="1" and (salllawnx="1" OR sspotlawnx="1") AND (mrspreaderx="1" OR mdspreaderx="1") AND pformx="granular" AND (tbroadx="1" OR toutairx="1" OR totherx="1" or tspotx="1" OR toutccx="1" OR toutfndx="1") GROUP BY hhidx	3	33	99	10.4762	87.6191
		4	19	76	6.0317	93.6508
		5	**10**	**50**	**3.1746**	**96.8254**
		6	1	6	0.3175	97.1429
		7	4	28	1.2698	98.4127
		8	2	16	0.6349	99.0476
		9	2	18	0.6349	99.6825
		31	1	31	0.3175	100
	Average = 2.04127	**Totals**	**315**	**643**		
12. Outdoor Lawn/Turf Treatment with Belly Grinder	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (salllawnx="1" OR sspotlawnx="1") AND mhhspreaderx="1" AND pformx="granular" AND (tbroadx="1" OR toutairx="1" OR totherx="1" or tspotx="1" OR toutccx="1" OR toutfndx="1") GROUP BY hhidx	1	72	72	59.5041	59.5041
		2	30	60	24.7934	84.2975
		3	4	12	3.3058	87.6033
		4	4	16	3.3058	90.9091
		5	**5**	**25**	**4.1322**	**95.0413**
		6	1	6	0.8264	95.8677
		7	3	21	2.4793	98.347
		8	1	8	0.8264	99.1734
		14	1	14	0.8264	99.9998
	Average = 1.933884	**Totals**	**121**	**234**		
13. Outdoor Lawn/Turf Treatment with Spoon **14. Outdoor Lawn/Turf Treatment with Cup** **16. Outdoor Perimeter Treatment with Shaker Can**	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (salllawnx="1" OR sspotlawnx="1") AND mgpourx="1" AND (pformx="granular" OR pformx="soluble concentrate/solid") AND (tbroadx="1" OR toutairx="1" OR totherx="1" or tspotx="1" OR toutccx="1" OR toutfndx="1") GROUP BY hhidx	1	101	101	46.1187	46.1187
		2	39	78	17.8082	63.9269
		3	19	57	8.6758	72.6027
		4	10	40	4.5662	77.1689
		5	9	45	4.1096	81.2785
		6	7	42	3.1963	84.4748
		7	3	21	1.3699	85.8447
		8	3	24	1.3699	87.2146
		9	6	54	2.7397	89.9543
		10	2	20	0.9132	90.8675
		11	7	77	3.1963	94.0638
		12	**6**	**72**	**2.7397**	**96.8035**
		14	1	14	0.4566	97.2601
		15	1	15	0.4566	97.7167
		22	2	44	0.9132	98.6299
		23	1	23	0.4566	99.0865
		29	1	29	0.4566	99.5431
		47	1	47	0.4566	99.9997
	Average = 3.666667	**Totals**	**219**	**803**		
15. Outdoor Lawn/Turf Treatment Dispersed by Hand	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (salllawnx="1" or sspotlawnx="1") and	1	92	92	44.6602	44.6602
		2	44	88	21.3592	66.0194
		3	21	63	10.1942	76.2136
		4	8	32	3.8835	80.0971

Table D.1. REJV Survey Search Criteria and Annual Frequency Calculations[1]						
Exposure Scenario	**Coding used in Cares NG REJV Database**	**Frequency (Applications)**	**Number of Households**	**Freq. × # of HH**	**%**	**% Total**
	mghandx="1" AND (pformx="granular" OR pformx="soluble concentrate/solid") AND (tbroadx="1" OR toutairx="1" OR totherx="1" or tspotx="1" OR toutccx="1" OR toutfndx="1") GROUP BY hhidx	5	14	70	6.7961	86.8932
		6	5	30	2.4272	89.3204
		7	3	21	1.4563	90.7767
		8	4	32	1.9417	92.7184
		9	2	18	0.9709	93.6893
		10	1	10	0.4854	94.1747
		11	**3**	**33**	**1.4563**	**95.631**
		12	1	12	0.4854	96.1164
		13	1	13	0.4854	96.6018
		14	3	42	1.4563	98.0581
		15	2	30	0.9709	99.029
		18	1	18	0.4854	99.5144
		34	1	34	0.4854	99.9998
	Average = 3.097087	**Totals**	**206**	**638**		
Paints/Preservatives/Stains						
17. Outdoor Paints/Preservative Wood Treatment with Airless Sprayer **18. Outdoor Paints/Preservative Wood Treatment with Brush** **20. Outdoor Paints/Preservative Wood Treatment with Roller**	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (tspotx="1" or tbroadx="1" or toutfndx="1" or toutccx="1" or totherx="1") and (sooutx="1" or sshedx="1" or sodeckx="1" or sbarnx="1" or shextx="1" or sohextx="1") and (mspritzx="1" or mdpourx="1" or mshandtrigx="1" or motherx="1") GROUP BY hhidx	1	555	555	39.0295	39.0295
		2	304	608	21.3783	60.4078
		3	159	477	11.1814	71.5892
		4	104	416	7.3136	78.9028
		5	91	455	6.3994	85.3022
		6	46	276	3.2349	88.5371
		7	28	196	1.9691	90.5062
		8	29	232	2.0394	92.5456
		9	19	171	1.3361	93.8817
		10	**17**	**170**	**1.1955**	**95.0772**
		11	11	121	0.7736	95.8508
		12	11	132	0.7736	96.6244
		13	8	104	0.5626	97.187
		14	10	140	0.7032	97.8902
		15	3	45	0.211	98.1012
		16	2	32	0.1406	98.2418
		17	4	68	0.2813	98.5231
		18	6	108	0.4219	98.945
		20	2	40	0.1406	99.0856
		22	2	44	0.1406	99.2262
		23	2	46	0.1406	99.3668
		24	1	24	0.0703	99.4371
		25	1	25	0.0703	99.5074
		26	4	104	0.2813	99.7887
		27	1	27	0.0703	99.859
		36	1	36	0.0703	99.9293
		40	1	40	0.0703	99.9996

Table D.1. REJV Survey Search Criteria and Annual Frequency Calculations[1]						
Exposure Scenario	**Coding used in Cares NG REJV Database**	**Frequency (Applications)**	**Number of Households**	**Freq. × # of HH**	**%**	**% Total**
	Average = 3.299578	**Totals**	**1422**	**4692**		
19. Outdoor Paints/Preservative Wood Treatment with Manually-pressurized handwand	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (tspotx="1" or tbroadx="1" or toutfndx="1" or toutccx="1" or totherx="1") and (sooutx="1" or sshedx="1" or sodeckx="1" or sbarnx="1" or shextx="1" or sohextx="1") and (mshandwandx="1") GROUP BY hhidx	1	307	307	49.3569	49.3569
		2	129	258	20.7395	70.0964
		3	58	174	9.3248	79.4212
		4	43	172	6.9132	86.3344
		5	19	95	3.0547	89.3891
		6	15	90	2.4116	91.8007
		7	11	77	1.7685	93.5692
		8	**9**	**72**	**1.4469**	**95.0161**
		9	6	54	0.9646	95.9807
		10	1	10	0.1608	96.1415
		11	6	66	0.9646	97.1061
		12	1	12	0.1608	97.2669
		14	1	14	0.1608	97.4277
		15	2	30	0.3215	97.7492
		17	3	51	0.4823	98.2315
		18	2	36	0.3215	98.553
		20	1	20	0.1608	98.7138
		21	1	21	0.1608	98.8746
		23	4	92	0.6431	99.5177
		24	1	24	0.1608	99.6785
		27	1	27	0.1608	99.8393
		34	1	34	0.1608	100.0001
	Average = 2.790996785	**Totals**	**622**	**1736**		
Liquid Concentrates						
21. Direct Application to Dogs with Dip Treatment	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (sdogx="1" AND (pnamex REGEXP 'dip' OR pnamenewx REGEXP 'dip')) OR (sdogx="1" AND mshampx IS NULL AND (pnamex REGEXP 'shampoo' OR pnamenewx REGEXP 'shampoo')) OR (sdogx="1" AND mdpourx="1" AND (pnamex NOT REGEXP 'shampoo|spray|mist|ear|heart|pill|tabs|tablets|spot|squeeze|drop' OR pnamex IS NULL) AND (pnamenewx NOT REGEXP 'shampoo|spray|mist|ear|heart|pill|tabs|tablets|spot|squeeze|drop' OR pnamenewx IS NULL)) GROUP BY hhidx	1	70	70	46.0526	46.0526
		2	28	56	18.4211	64.4737
		3	15	45	9.8684	74.3421
		4	13	52	8.5526	82.8947
		5	5	25	3.2895	86.1842
		6	4	24	2.6316	88.8158
		7	5	35	3.2895	92.1053
		9	**6**	**54**	**3.9474**	**96.0527**
		10	2	20	1.3158	97.3685
		14	1	14	0.6579	98.0264
		16	1	16	0.6579	98.6843
		18	1	18	0.6579	99.3422
		30	1	30	0.6579	100.0001
	Average = 3.019736842	**Totals**	**152**	**459**		
22. Direct Body Wipe Application to	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and	1	122	122	23.2824	23.2824
		2	84	168	16.0305	39.3129
		3	49	147	9.3511	48.664

Table D.1. REJV Survey Search Criteria and Annual Frequency Calculations[1]						
Exposure Scenario	**Coding used in Cares NG REJV Database**	**Frequency (Applications)**	**Number of Households**	**Freq. × # of HH**	**%**	**% Total**
Dogs/Horses with Sponge/Towelette	(sdogx="1" AND mspotx="1" AND (pformx<>'Dust' OR pformx IS NULL) AND (pnamex NOT REGEXP 'shampoo|spray|mist|ear|heart|pill|tabs|tablets|dip|sponge' OR pnamex IS NULL) AND (pnamenewx NOT REGEXP 'shampoo|spray|mist|ear|heart|pill|tabs|tablets|dip|sponge' OR pnamenewx IS NULL)) OR (sdogx="1" AND mpotherx="1" AND pformx="ready-to-use solution" AND (pnamex NOT REGEXP 'shampoo|spray|mist|ear|heart|pill|tabs|tablets|dip|sponge' OR pnamex IS NULL) AND (pnamenewx NOT REGEXP 'shampoo|spray|mist|ear|heart|pill|tabs|tablets|dip|sponge' OR pnamenewx IS NULL)) OR (sdogx="1" AND mdpourx="1" AND pformx="ready-to-use solution" AND (pnamex NOT REGEXP 'shampoo|spray|mist|ear|heart|pill|tabs|tablets|dip|sponge' OR pnamex IS NULL) AND (pnamenewx NOT REGEXP 'shampoo|spray|mist|ear|heart|pill|tabs|tablets|dip|sponge' OR pnamenewx IS NULL)) OR (skennelx="1" AND mspotx="1" AND tdirectx="1" AND pformx="ready-to-use solution" AND (pnamex NOT REGEXP 'shampoo|spray|mist|ear|heart|pill|tabs|tablets|dip|sponge' OR pnamex IS NULL) AND (pnamenewx NOT REGEXP 'shampoo|spray|mist|ear|heart|pill|tabs|tablets|dip|sponge' OR pnamenewx IS NULL)) OR shorsex="1" AND motherx="1" AND (pnamex LIKE '%wipe%' OR pnamenewx LIKE '%wipe%') GROUP BY hhidx	4	41	164	7.8244	56.4884
		5	36	180	6.8702	63.3586
		6	29	174	5.5344	68.893
		7	17	119	3.2443	72.1373
		8	25	200	4.771	76.9083
		9	26	234	4.9618	81.8701
		10	14	140	2.6718	84.5419
		11	19	209	3.626	88.1679
		12	20	240	3.8168	91.9847
		13	6	78	1.145	93.1297
		14	5	70	0.9542	94.0839
		15	**5**	**75**	**0.9542**	**95.0381**
		16	3	48	0.5725	95.6106
		18	2	36	0.3817	95.9923
		19	1	19	0.1908	96.1831
		20	3	60	0.5725	96.7556
		21	1	21	0.1908	96.9464
		22	7	154	1.3359	98.2823
		23	1	23	0.1908	98.4731
		24	3	72	0.5725	99.0456
		25	1	25	0.1908	99.2364
		26	1	26	0.1908	99.4272
		28	1	28	0.1908	99.618
		30	1	30	0.1908	99.8088
		32	1	32	0.1908	99.9996
	Average = 5.522900763	**Totals**	**524**	**2894**		
28. Indoor Perimeter/Spot/ Bedbug (course application); Perimeter /Spot/ Bedbug (pinstream application); Crack and Crevice with Manually-pressurized handwand (w/ or w/o pin stream nozzle)	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (pformx REGEXP 'concentrate|solution|pressurized|water') and (sdinrmx="1" or sbeddingx="1" or sbedrmx="1" or slivrmx="1" or ssunrmx="1" or sofficex="1" or sfamrmx="1" or splayx="1" or skitchx="1" or sutlrmx="1" or sbathx="1" or sporchx="1" or satticx="1" or sgaragex="1" or sgarageuax="1" or subasx="1" or scarpetx="1" or scupbrdsx="1" or soinareax="1") and (mshandwandx="1") and (tspotx="1" or tinccx="1" or tinperimx="1") GROUP BY hhidx	1	80	80	57.971	57.971
		2	31	62	22.4638	80.4348
		3	8	24	5.7971	86.2319
		4	5	20	3.6232	89.8551
		5	5	25	3.6232	93.4783
		6	**4**	**24**	**2.8986**	**96.3769**
		7	2	14	1.4493	97.8262
		12	1	12	0.7246	98.5508
		14	1	14	0.7246	99.2754
		17	1	17	0.7246	100
	Average = 2.115942029	**Totals**	**138**	**292**		
29. Indoor/Outdoor Garden/Tree/Ornamental Application with Manually-	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (sornamx="1" or sflowerx="1" or sshrubx="1" or svegx="1" or streex="1" or sotreex="1") AND mshandwandx="1" AND (pformx REGEXP	1	128	128	46.5455	46.5455
		2	52	104	18.9091	65.4546
		3	27	81	9.8182	75.2728
		4	18	72	6.5455	81.8183
		5	10	50	3.6364	85.4547

Table D.1. REJV Survey Search Criteria and Annual Frequency Calculations[1]						
Exposure Scenario	**Coding used in Cares NG REJV Database**	**Frequency (Applications)**	**Number of Households**	**Freq. × # of HH**	**%**	**% Total**
pressurized handwand	'concentrate|solution|pressurized|water') AND (tspotx="1" or tbroadx="1" or tinairx="1" or toutairx="1")	6	13	78	4.7273	90.182
		7	6	42	2.1818	92.3638
30. Outdoor Garden/Tree/Ornamental Application with Manually-pressurized handwand	GROUP BY hhidx	8	3	24	1.0909	93.4547
		9	1	9	0.3636	93.8183
		10	**3**	**30**	**1.0909**	**94.9092**
		11	1	11	0.3636	95.2728
		12	2	24	0.7273	96.0001
		13	2	26	0.7273	96.7274
		14	1	14	0.3636	97.091
		17	2	34	0.7273	97.8183
		20	1	20	0.3636	98.1819
		22	1	22	0.3636	98.5455
		25	1	25	0.3636	98.9091
		26	1	26	0.3636	99.2727
		38	1	38	0.3636	99.6363
		48	1	48	0.3636	99.9999
	Average = 3.294545	**Totals**	**275**	**906**		
31. Outdoor Lawn/Turf/Perimeter Treatment with Manually-pressurized handwand	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (salllawnx="1" or sspotlawnx="1") AND mshandwandx="1" AND (pformx REGEXP 'concentrate|solution|pressurized|water') AND (tspotx="1" or tbroadx="1" or toutairx="1") GROUP BY hhidx	1	225	225	50.5618	50.5618
		2	80	160	17.9775	68.5393
		3	44	132	9.8876	78.4269
		4	27	108	6.0674	84.4943
		5	20	100	4.4944	88.9887
		6	15	90	3.3708	92.3595
		7	7	49	1.573	93.9325
		8	**5**	**40**	**1.1236**	**95.0561**
		9	1	9	0.2247	95.2808
		10	3	30	0.6742	95.955
		11	6	66	1.3483	97.3033
		12	2	24	0.4494	97.7527
		13	4	52	0.8989	98.6516
		14	1	14	0.2247	98.8763
		15	1	15	0.2247	99.101
		16	1	16	0.2247	99.3257
		17	2	34	0.4494	99.7751
		23	1	23	0.2247	99.9998
	Average = 2.667416	**Totals**	**445**	**1187**		
32. Outdoor Garden/Tree/Ornamental Application with backpack	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (sornamx="1" or sflowerx="1" or sshrubx="1" or svegx="1" or streex="1" or sotreex="1") AND msbackpackx="1" AND (pformx REGEXP 'concentrate|solution|pressurized|water') AND (tspotx="1" or tbroadx="1" or tinairx="1" or	1	11	11	55	55
		2	5	10	25	80
		5	2	10	10	90
		6	**1**	**6**	**5**	**95**
33. Indoor/Outdoor		7	1	7	5	100

Table D.1. REJV Survey Search Criteria and Annual Frequency Calculations[1]						
Exposure Scenario	**Coding used in Cares NG REJV Database**	**Frequency (Applications)**	**Number of Households**	**Freq. × # of HH**	**%**	**% Total**
Garden/Tree/Ornamental Application with Backpack	toutairx="1") GROUP BY hhidx					
	Average = 2.2	**Totals**	**20**	**44**		
34. Outdoor Lawn/Turf/Perimeter Treatment with Backpack	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (salllawnx="1" or sspotlawnx="1") AND msbackpackx="1" AND (pformx REGEXP 'concentrate|solution|pressurized|water') AND (tspotx="1" or tbroadx="1" or toutairx="1") GROUP BY hhidx	**1**	**18**	**18**	**56.25**	**56.25**
		2	8	16	25	81.25
		3	1	3	3.125	84.375
		4	1	4	3.125	87.5
		5	1	5	3.125	90.625
		9	1	9	3.125	93.75
		12	**1**	12	**3.125**	**96.875**
		14	1	14	3.125	100
	Average = 2.53125	**Totals**	**32**	**81**		
Other. Indoor Barn Misting System	SELECT hhidx, count(*) as total FROM application_update WHERE allyrx="1" and usablex="1" and (pformx REGEXP 'concentrate|solution|pressurized|water') and sbarnx="1" GROUP BY hhidx	**1**	**64**	**64**	**60.3774**	**60.3774**
		2	20	40	18.8679	79.2453
		3	7	21	6.6038	85.8491
		4	3	12	2.8302	88.6793
		5	3	15	2.8302	91.5095
		6	2	12	1.8868	93.3963
		7	**2**	**14**	**1.8868**	**95.2831**
		10	1	10	0.9434	96.2265
		12	2	24	1.8868	98.1133
		16	1	16	0.9434	99.0567
		49	1	49	0.9434	100.0001
	Average = 2.613208	**Totals**	**106**	**277**		

1. https://caresng.cremeglobal.com/index.html

Table D.2. Typical Residue for Indoor Fogger Residential Dermal Cancer Assessment (based on 2 Applications per year as shown in Table D.1)		
Day of year	**Deposited Residue (ug/cm^2)**	
	7 Day RTI	**30 Day RTI**
1	4.8	4.8
2	4.343219607	4.343219607
3	3.929907615	3.929907615
4	3.555927459	3.555927459
5	3.217536221	3.217536221
6	2.911347167	2.911347167
7	2.634295853	2.634295853
8	7.434295853	2.383609458
9	6.726829065	2.156779028
10	6.086686643	1.951534367
11	5.507461826	1.765821318

Table D.2. Typical Residue for Indoor Fogger Residential Dermal Cancer Assessment (based on 2 Applications per year as shown in Table D.1)		
Day of year	**Deposited Residue (ug/cm^2)**	
	7 Day RTI	**30 Day RTI**
12	4.983357539	1.597781202
13	4.509128368	1.445732217
14	4.08002807	1.308152607
15	3.691762065	1.183665427
16	3.340444455	1.071024769
17	3.022559135	0.969103286
18	2.734924604	0.876880915
19	2.474662117	0.793434663
20	2.239166881	0.717929372
21	2.026081979	0.64960936
22	1.833274786	0.587790856
23	1.658815624	0.53185516
24	1.500958447	0.48124245
25	1.358123365	0.435446176
26	1.228880839	0.394007993
27	1.111937366	0.356513175
28	1.006122535	0.322586461
29	0.910377317	0.291888301
30	0.823743461	0.264111456
31	0.745353906	5.064111456
32	0.674424104	4.582197535
33	0.610244165	4.146143786
34	0.552171755	3.751586038
35	0.499625665	3.394575424
36	0.452079996	3.071538862
37	0.409058897	2.779243294
38	0.370131796	2.514763326
39	0.334909099	2.275451955
40	0.303038284	2.058914072
41	0.274200378	1.862982493
42	0.248106762	1.685696268
43	0.224496282	1.525281059
44	0.203132636	1.380131375
45	0.18380201	1.24879451
46	0.166310936	1.129956
47	0.150484358	1.02242647
48	0.136163878	0.925129727
49	0.123206172	0.837091994

Table D.2. Typical Residue for Indoor Fogger Residential Dermal Cancer Assessment (based on 2 Applications per year as shown in Table D.1)		
Day of year	**Deposited Residue (ug/cm^2)**	
	7 Day RTI	**30 Day RTI**
50	0.111481555	0.757432158
51	0.100872682	0.685352958
52	0.091273377	0.620133001
53	0.082587567	0.561119544
54	0.074728321	0.507721959
55	0.067616981	0.459405827
56	0.061182374	0.415687582
57	0.055360102	0.376129678
58	0.050091891	0.340336207
59	0.045325018	0.307948935
60	0.041011772	0.278643719
61	0.037108986	0.252127263
62	0.033577599	0.228134182
63	0.030382268	0.206424344
64	0.027491013	0.186780471
65	0.024874897	0.169005959
66	0.022507738	0.152922915
67	0.020365843	0.138370376
68	0.018427777	0.125202694
69	0.016674142	0.113288082
70	0.015087388	0.102507296
71	0.013651633	0.092752437
72	0.012352508	0.083925875
73	0.011177012	0.075939272
74	0.010113378	0.068712695
75	0.009150963	0.062173818
76	0.008280134	0.056257197
77	0.007492175	0.050903617
78	0.0067792	0.046059497
79	0.006134074	0.041676356
80	0.00555034	0.037710327
81	0.005022155	0.034121715
82	0.004544234	0.030874604
83	0.004111793	0.027936497
84	0.003720504	0.025277988
85	0.003366451	0.022872469
86	0.003046091	0.020695866
87	0.002756217	0.018726394

Table D.2. Typical Residue for Indoor Fogger Residential Dermal Cancer Assessment (based on 2 Applications per year as shown in Table D.1)		
Day of year	**Deposited Residue (ug/cm^2)**	
	7 Day RTI	**30 Day RTI**
88	0.002493928	0.016944342
89	0.0022566	0.015331875
90	0.002041856	0.013872854
91	0.001847548	0.012552677
92	0.00167173	0.011358132
93	0.001512644	0.010277263
94	0.001368697	0.009299252
95	0.001283	0.008414311
96	0.001283	0.007613584
97	0.001283	0.006889055
98	0.001283	0.006233475
99	0.001283	0.005640281
100	0.001283	0.005103538
101	0.001283	0.004617872
102	0.001283	0.004178423
103	0.001283	0.003780794
104	0.001283	0.003421004
105	0.001283	0.003095452
106	0.001283	0.002800881
107	0.001283	0.002534342
108	0.001283	0.002293167
109	0.001283	0.002074944
110	0.001283	0.001877487
111	0.001283	0.00169882
112	0.001283	0.001537156
113	0.001283	0.001390876
114	0.001283	0.001283
114 through 365	0.001283 each day	0.001283 each day
Average Residue	**0.284517703**	**0.277956683**

Lower RTIs result in a slightly higher average residue due to the greater accumulation early on in the dissipation calculation.

APPENDIX E. Occupational Hander Non-Cancer and Cancer Risk Estimates

Table 8.1.1. Occupational Handler Non-Cancer and Cancer Exposure and Risk Estimates for Permethrin Agricultural Uses.

Exposure Scenario	Crop or Target		Unit Exposure (µg/lb ai)[1]		Maximum Application Rate[3]	Area Treated or Amount Handled Daily[4]	Non-Cancer		Cancer			
			Dermal	Inhalation			Inhalation		Private Handler	Commercial Applicator	Private Handler	Commercial Applicator
			PPE[2]				Dose (mg/kg/day)[5]	MOE[6]	Total LADD (mg/kg/day)[7]		Total Cancer Risk Estimate[8]	
Mixer/Loader												
WDG: Aerial	Orchard/Vineyard		227	8.96	0.4 lb ai/A	350 acres	0.016	600	0.000353	0.00106	3E-06	1E-05
	Field Crop, Typical				0.3 lb ai/A	350 acres	0.012	790	0.000266	0.000797	3E-06	8E-06
	Field Crop, High-acreage				0.2 lb ai/A	1200 acres	0.027	350	0.000607	0.00182	6E-06	2E-05
WDG: Airblast	Orchard/Vineyard				0.4 lb ai/A	40 acres	0.018	5,200	0.0000404	0.000121	4E-07	1E-06
WDG: Chemigation	Orchard/Vineyard				0.4 lb ai/A	350 acres	0.016	600	0.000353	0.00106	3E-06	1E-05
	Field Crop, Typical				0.3 lb ai/A	350 acres	0.012	790	0.000266	0.000797	3E-06	8E-06
	Field Crop, High-acreage				0.2 lb ai/A	350 acres	0.078	1,200	0.000177	0.000531	2E-06	5E-06
WDG: Groundboom	Orchard/Vineyard				0.4 lb ai/A	40 acres	0.018	5,200	0.0000404	0.000121	4E-07	1E-06
	Field Crop, Typical				0.3 lb ai/A	80 acres	0.027	3,500	0.0000607	0.000182	6E-07	2E-06
	Field Crop, High-acreage				0.2 lb ai/A	200 acres	0.045	2,100	0.000101	0.000304	1E-06	3E-06
G: Aerial	Orchard/Vineyard		8.4	1.7	0.25 lb ai/A	350 acres	0.0019	5,000	0.0000266	0.0000797	3E-07	8E-07
L/EC: Aerial	Orchard/Vineyard		220	0.219	0.4 lb ai/A	350 acres	0.00038	24,000	0.000161	0.000483	2E-06	5E-06
L/EC: Impregnation	Dry Bulk Fertilizer	Commercial Treatment	No Data	0.083 Engineering Controls	3 lb ai/ton	960 tons	0.0030	3,100	0.000162	0.000487	2E-06	5E-06
		On-Farm	220	0.219	0.3 lb ai/acre	160 acres	0.00013	71,000	0.0000553	0.000166	5E-07	2E-06
L/EC: Aerial	Field Crop, Typical				0.3 lb ai/A	350 acres	0.00029	33,000	0.000121	0.000362	1E-06	3E-06
	Field Crop, High-acreage				0.2 lb ai/A	1200 acres	0.00066	14,000	0.000277	0.00083	3E-06	8E-06
L/EC: Airblast	Orchard/Vineyard				0.4 lb ai/A	40 acres	0.000044	210,000	0.0000183	0.000055	2E-07	5E-07
L/EC: Chemigation	Orchard/Vineyard				0.4 lb ai/A	350 acres	0.00038	24,000	0.000161	0.000483	2E-06	5E-06
	Field Crop, Typical				0.3 lb ai/A	350 acres	0.00029	33,000	0.000121	0.000362	1E-06	3E-06
	Field Crop, High-acreage				0.2 lb ai/A	350 acres	0.00019	49,000	0.0000804	0.000241	8E-07	2E-06
L/EC: Groundboom	Orchard/Vineyard				0.4 lb ai/A	40 acres	0.000044	210,000	0.0000183	0.000055	2E-07	5E-07

Table 8.1.1. Occupational Handler Non-Cancer and Cancer Exposure and Risk Estimates for Permethrin Agricultural Uses.											
Exposure Scenario	**Crop or Target**	**Unit Exposure (µg/lb ai)[1]**		**Maximum Application Rate[3]**	**Area Treated or Amount Handled Daily[4]**	**Non-Cancer**		**Cancer**			
		Dermal	**Inhalation**			**Inhalation**		**Private Handler**	**Commercial Applicator**	**Private Handler**	**Commercial Applicator**
		PPE[2]				**Dose (mg/kg/day)[5]**	**MOE[6]**	**Total LADD (mg/kg/day)[7]**		**Total Cancer Risk Estimate[8]**	
	Field Crop, Typical			0.3 lb ai/A	80 acres	0.000066	140,000	0.0000277	0.000083	3E-07	8E-07
	Field Crop, High-acreage			0.2 lb ai/A	200 acres	0.00011	85,000	0.000046	0.000138	4E-07	1E-06
L/EC: Stationary Fogger	Mushroom House			0.0000018 lbs ai/cu ft	1,000,000 cu ft	0.00000493	1,900,000	0.00000207	0.0000062	2E-08	6E-08
WP: Aerial	Orchard/Vineyard	77.7	2.75	0.4 lb ai/A	350 acres	0.075	120	0.000114	0.000343	1E-06	3E-06
	Field Crop, Typical			0.3 lb ai/A	350 acres	0.057	170	0.0000858	0.000257	8E-07	2E-06
	Field Crop, High-acreage			0.2 lb ai/A	1200 acres	0.013	73	0.000195	0.000586	2E-06	6E-06
WP: Airblast	Orchard/Vineyard			0.4 lb ai/A	40 acres	0.0086	1,100	0.000013	0.0000391	1E-07	4E-07
WP: Chemigation	Orchard/Vineyard			0.4 lb ai/A	350 acres	0.075	120	0.000114	0.000343	1E-06	3E-06
	Field Crop, Typical			0.3 lb ai/A	350 acres	0.057	170	0.0000858	0.000257	8E-07	2E-06
	Field Crop, High-acreage			0.2 lb ai/A	350 acres	0.038	250	0.0000572	0.000171	5E-07	2E-06
WP: Groundboom	Orchard/Vineyard			0.4 lb ai/A	40 acres	0.0086	1,100	0.000013	0.0000391	1E-07	4E-07
	Field Crop, Typical			0.3 lb ai/A	80 acres	0.013	730	0.0000195	0.0000586	2E-07	6E-07
	Field Crop, High-acreage			0.2 lb ai/A	200 acres	0.022	440	0.0000327	0.0000981	3E-07	9E-07
WP: Stationary Fogger	Mushroom House			0.0000018 lbs ai/cu ft	1,000,000 cu ft	0.0000619	150,000	0.00000148	0.00000443	1E-08	4E-08
Applicator											
Spray: Aerial	Orchard/Vineyard	2.08 Engineering Controls	0.0049 Engineering Controls	0.4 lb ai/A	350 acres	0.0000086	1,100,000	0.00000159	0.00000476	2E-08	5E-08
	Field Crop, Typical			0.3 lb ai/A	350 acres	0.0000064	1,500,000	0.00000118	0.00000355	1E-08	3E-08
	Field Crop, High-acreage			0.2 lb ai/A	1200 acres	0.000015	630,000	0.00000272	0.00000815	3E-08	8E-08
Spray: Airblast	Orchard/Vineyard	1770	4.71	0.4 lb ai/A	40 acres	0.00094	9,900	0.000155	0.000465	1E-06	4E-06
Spray: Groundboom	Orchard/Vineyard	78.6	0.34	0.4 lb ai/A	40 acres	0.000068	140,000	0.00000723	0.0000217	7E-08	2E-07
	Field Crop, Typical			0.3 lb ai/A	80 acres	0.00010	92,000	0.0000108	0.0000325	1E-07	3E-07
	Field Crop, High-acreage			0.2 lb ai/A	200 acres	0.00018	55,000	0.0000181	0.0000542	2E-07	5E-07
Impregnated Dry Bulk Fertilizer	Field Crop, Typical Commercial Treatment	9.9	1.2	0.3 lb ai/A	320 acres	0.00144	6,500	0.0000225	0.0000675	2E-07	6E-07
	Field Crop, Typical				160 acres	0.00072	13,000	0.0000113	0.0000338	1E-07	3E-07

Table 8.1.1. Occupational Handler Non-Cancer and Cancer Exposure and Risk Estimates for Permethrin Agricultural Uses.											
Exposure Scenario	**Crop or Target**	**Unit Exposure (µg/lb ai)[1]**		**Maximum Application Rate[3]**	**Area Treated or Amount Handled Daily[4]**	**Non-Cancer**		**Cancer**			
		Dermal	**Inhalation**			**Inhalation**		**Private Handler**	**Commercial Applicator**	**Private Handler**	**Commercial Applicator**
		PPE[2]				**Dose (mg/kg/day)[5]**	**MOE[6]**	**Total LADD (mg/kg/day)[7]**		**Total Cancer Risk Estimate[8]**	
	On-Farm Treatment										
	Field Crop, High Acreage Commercial Treatment				320 acres	0.00144	6,500	0.0000225	0.0000675	2E-07	6E-07
	Field Crop, High Acreage On-Farm Treatment				160 acres	0.00072	13,000	0.0000113	0.0000338	1E-07	3E-07
G: Aerial	Orchard/Vineyard	1.7 Engineering Controls	1.3 Engineering Controls	0.25 lb ai/A	350 acres	0.0014	6,500	0.0000183	0.000055	2E-07	5E-07
Flagger											
Spray: Aerial	Orchard/Vineyard	11	0.35	0.4 lb ai/A	350 acres	0.00061	15,000	0.0000154	0.0000461	1E-07	4E-07
	Field Crop, Typical			0.3 lb ai/A		0.00046	20,000	0.0000115	0.0000346	1E-07	3E-07
	Field Crop, High-acreage			0.2 lb ai/A		0.00031	31,000	0.00000767	0.000023	7E-08	2E-07
G: Aerial	Orchard/Vineyard	2.75	0.15	0.25 lb ai/A		0.00016	57,000	0.00000323	0.0000097	3E-08	9E-08
Mixer/Loader/Applicator											
WDG: Backpack	Orchard/Vineyard (ground)	8260	2.58	0.0036 lb ai/gallon	40 gallons	0.0000047	2,000,000	0.0000061	0.0000183	6E-08	2E-07
WDG: Mechanically-pressurized Handgun	Orchard/Vineyard (foliar/ground)	6050	8.68		1000 gallons	0.00039	24,000	0.000115	0.000346	1E-06	3E-06
	Field Crop, Typical (foliar/ground)			0.0055 lb ai/gallon		0.00060	16,000	0.000176	0.000527	2E-06	5E-06
L/EC: Backpack	Orchard/Vineyard (ground)	8260	2.58	0.0036 lb ai/gallon	40 gallons	0.0000047	2,000,000	0.0000061	0.0000183	6E-08	2E-07
L/EC: Fogging Equipment	Mushroom House	No Data	8916	0.0000018 lbs ai/cu ft	1,000,000 cu ft	0.2	47	No Data	No Data	No Data	No Data
L/EC: Manually-pressurized Handwand	Mushroom House	100000	30	0.267 lbs ai/gal	40 gallons	0.004	2300	0.00547	0.0164	5E-05	2E-04
L/EC: Mechanically-	Orchard/Vineyard	6050	8.68	0.0036 lb ai/gallon	1000 gallons	0.00039	24,000	0.000115	0.000346	1E-06	3E-06

Table 8.1.1. Occupational Handler Non-Cancer and Cancer Exposure and Risk Estimates for Permethrin Agricultural Uses.											
Exposure Scenario	**Crop or Target**	**Unit Exposure (µg/lb ai)[1]**		**Maximum Application Rate[3]**	**Area Treated or Amount Handled Daily[4]**	**Non-Cancer**		**Cancer**			
		Dermal	**Inhalation**			**Inhalation**		**Private Handler**	**Commercial Applicator**	**Private Handler**	**Commercial Applicator**
		PPE[2]				**Dose (mg/kg/day)[5]**	**MOE[6]**	**Total LADD (mg/kg/day)[7]**		**Total Cancer Risk Estimate[8]**	
pressurized Handgun	(foliar/ground)										
	Field Crop, Typical (foliar/ground)			0.0055 lb ai/gallon		0.00060	16,000	0.000176	0.000527	2E-06	5E-06
WP: Backpack	Orchard/Vineyard (ground)	8260	2.58	0.0036 lb ai/gallon	40 gallons	0.0000047	2,000,000	0.0000061	0.0000183	6E-08	2E-07
WP: Fogging Equipment	Mushroom House	No Data	8916	0.0000018 lbs ai/cu ft	1,000,000 cu ft	0.2	47	No Data	No Data	No Data	No Data
WP: Manually-pressurized Handwand	Mushroom House	100000	30	0.267 lbs ai/gal	40 gallons	0.004	2300	0.00547	0.0164	5E-05	2E-04
WP: Mechanically-pressurized Handgun	Orchard/Vineyard (foliar)	6050	8.68	0.0036 lb ai/gallon	1000 gallons	0.00039	24,000	0.000115	0.000346	1E-06	3E-06
	Orchard/Vineyard (ground drench)	4310	3931	0.0036 lb ai/gallon		0.18	53	0.00226	0.00679	2E-05	7E-05
	Field Crop, Typical (foliar)	6050	8.68	0.0055 lb ai/gallon		0.00060	16,000	0.000176	0.000527	2E-06	5E-06
	Field Crop, Typical (ground drench)	4310	3931			0.27	35	0.000176	0.000527	2E-06	5E-06
Loader/Applicator											
G: Backpack	Orchard/Vineyard (ground)	155	23.8	0.25 lb ai/A	1 acre	0.000074	130,000	0.00000111	0.00000333	1E-08	3E-08
G: Belly Grinder	Orchard/Vineyard (broadcast)	10000	62			0.00019	48,000	0.000015	0.000045	1E-07	4E-07
G: Rotary Spreader		440	10		5 acres	0.00016	60,000	0.00000471	0.0000141	5E-08	1E-07

1 Based on the "Occupational Pesticide Handler Unit Exposure Surrogate Reference Table" (http://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/occupational-pesticide-handler-exposure-data); Level of mitigation: Baseline PPE with no gloves and no respirator, Eng. Controls.
2 PPE = Baseline (i.e., long sleeved shirt, long pants, shoes plus socks) no gloves, and no respirator unless otherwise indicated
3 Based on registered uses listed in Appendix A, Tables 4.1 and 4.2.
4 Exposure Science Advisory Council Policy #9.1.
5 Inhalation Dose = Inhalation Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) × Application Rate (lb ai/acre or gal) × Area Treated or Amount Handled Daily (A or gal/day) ÷ BW (80 kg).
6 Inhalation MOE = Inhalation HED (mg/kg/day) ÷ Inhalation Dose (mg/kg/day).

Total LADD = Dermal LADD + Inhalation LADD

Total Cancer Risk Estimate = Total LADD × Q_1^*, where Q_1^* = **9.567 x 10-3** $(mg/kg/day)^{-1}$

Table 8.1.2. Occupational Handler Non-Cancer and Cancer Exposure and Risk Estimates for Permethrin Non-Agricultural Uses.									
Exposure Scenario Formulation: Equipment	**Crop or Target**	**Unit Exposure (µg/lb ai)[1]**		**Maximum Application Rate[3]**	**Area Treated or Amount Handled Daily[4]**	**Non-Cancer**		**Cancer**	
		Dermal	**Inhalation**			**Inhalation**		**Commercial Applicator**	
		PPE[2]				**Dose (mg/kg/day)[5]**	**MOE[6]**	**Total LADD[7]**	**Cancer Risk Estimate[8]**
Mixer/Loader									
L/EC: Dip	Livestock	220	0.219	0.0023 lb ai/animal	400 animals	0.0000025	3,700,000	0.0000032	3E-08
DF/WDG: Dip		227	8.96			0.00010	91,000	0.0000070	7E-08
DF/WDG: Aerial	Conifer Pine Seed Orchard	227	8.96	1.6 lbs ai/acre	125 acres	0.022	420	0.00051	1E-05
DF/WDG: Chemigation	Greenhouse Ornamentals	227	8.96	0.2 lbs ai/acre	60 acres	0.0014	6,900	0.000091	9E-07
DF/WDG: Groundboom		227	8.96					0.000091	9E-07
L/EC: Aerial	Aquatic Vector Control	220	0.219	0.007 lb ai/acre	250 acres	0.0000048	2,000,000	0.0000061	6E-08
	Forestry	220	0.219	0.6 lb ai/acre	1,200 acres	0.0020	4,700	0.0025	2E-05
	Forestry ULV/Wide Area	220	0.219		7,500 acres	0.012	760	0.016	1E-04
	Terrestrial Vector Control: ULV	220	0.219	0.007 lbs ai/acre	7,500 acres	0.00014	65,000	0.00018	2E-06
L/EC: Truck-mounted Fogger	Terrestrial Vector Control: ULV	220	0.219	0.007 lbs ai/acre	3000 acres	0.000058	160,000	0.000073	7E-07
	Terrestrial Vector Control	220	0.219		250 acres	0.0000048	2,000,000	0.0000066	6E-08
L/EC: Groundboom	Golf course	220	0.219	0.79 lb ai/acre	40 acres	0.000087	110,000	0.00011	1E-06
	Field-grown and Greenhouse Ornamentals	220	0.219	0.2 lb ai/acre	40 acres	0.0000219	430,000	0.0000028	3E-08
L/EC: Boom Sprayer	Aquatic Vector Control	220	0.219	0.007 lbs ai/acre	30 acres	5.8E-07	16,000,000	0.00000073	7E-09
L/EC: Automatic Misting System	Barn Misting System	220	0.219	0.000031 lb ai/cu ft	100,000 cu ft	0.000085	110,000	0.00011	1E-06
	Residential Misting System	220	0.219	0.0023 lb ai/gal	1,000 gallons	0.0000063	1,500,000	0.0000079	8E-08
L/EC: Stationary Fogger	Warehouse	220	0.219	0.00000036 lb ai/cu ft	100,000 cu ft	0.00000099	9,500,000	0.0000012	1E-08
	Indoor Barnyard / Livestock House	220	0.219	0.000031 lb ai/cu ft	100,000 cu ft	0.000085	110,000	0.00011	1E-06
WP: Aerial	Conifer Pine Seed	77.7	2.75	1.6 lbs ai/acre	125 acres	0.0069	1,400	0.00049	5E-06

Table 8.1.2. Occupational Handler Non-Cancer and Cancer Exposure and Risk Estimates for Permethrin Non-Agricultural Uses.									
Exposure Scenario Formulation: Equipment	**Crop or Target**	**Unit Exposure (µg/lb ai)[1]**		**Maximum Application Rate[3]**	**Area Treated or Amount Handled Daily[4]**	**Non-Cancer**		**Cancer**	
		Dermal	**Inhalation**			**Inhalation**		**Commercial Applicator**	
		PPE[2]				**Dose (mg/kg/day)[5]**	**MOE[6]**	**Total LADD[7]**	**Cancer Risk Estimate[8]**
	Orchard								
WP: Chemigation	Greenhouse Ornamentals	77.7	2.75	0.2 lb ai/acre	60 acres	0.00041	23,000	0.000029	3E-07
WP: Groundboom	Greenhouse Ornamentals	77.7	2.75					0.000029	3E-07
Applicator									
RTU (D): Dust Bag	Livestock	227	8.96	0.0025 lb ai/animal	1000 poultry	0.000728	33,000	0.000019	2E-07
Spray: Aerial	Aquatic Vector Control	2.08 Engineering Controls	0.0049 Engineering Controls	0.007 lbs ai/acre	250 acres	0.00000011	88,000,000	5.9E-08	6E-10
	Conifer Pine Seed Orchard			1.6 lbs ai/acre	125 acres	0.000012	760,000	0.0000068	0.0000068
	Forestry			0.6 lbs ai/acre	1,200 acres	0.000044	210,000	0.000025	2E-07
	Forestry ULV/Wide Area				7,500 acres	0.00028	34,000	0.00015	1E-06
	Terrestrial Vector Control: ULV			0.007 lbs ai/acre	7,500 acres	0.0000032	2,900,000	0.0000018	2E-08
Spray: Truck-mounted Fogger	Terrestrial Vector Control: ULV	1770	4.71	0.007 lbs ai/acre	3,000 acres	0.0012	7,600	0.00061	6E-06
	Terrestrial Vector Control	1770	4.71		250 acres	0.00010	91,000	0.000051	5E-07
Spray: Groundboom	Golf Course	78.6	0.34	0.79 lbs ai/acre	40 acres	0.000134	70,000	0.000042	4E-07
	Greenhouse Ornamentals	78.6	0.34	0.2 lbs ai/acre	60 acres	0.000051	180,000	0.000016	2E-07
Spray: Boom sprayer	Aquatic Vector Control	78.6	0.34	0.007 lbs ai/acre	30 acres	0.00000089	10,000,000	0.00000028	3E-09
RTU (L): Dip	Domestic Animal	54300	26.6	0.006 lb ai/gal	10 gallons	0.00002	470,000	0.000050	5E-07
RTU (L): Pour-in/on	Livestock	220	0.219	0.0017 lb ai/animal	400 animals	0.0000019	5,000,000	0.0000024	2E-08
	Domestic Animal	220	0.219	0.007 lb ai/animal	8 animals	0.00000015	61,000,000	0.00000019	2E-09
RTU (L): Shampoo	Domestic Animal	2098000	292	0.0014 lbs ai/animal	8 animals	0.000041	230,000	0.00036	3E-06
RTU (L): Sponge	Livestock (Horses)	844000	208	0.0062 ai/animal	25 animals	0.00040	23,000	0.0020	2E-05
	Domestic Animal	844000	208	0.0062 ai/animal	8 animals	0.00013	73,000	0.00064	6E-06

Table 8.1.2. Occupational Handler Non-Cancer and Cancer Exposure and Risk Estimates for Permethrin Non-Agricultural Uses.									
Exposure Scenario Formulation: Equipment	**Crop or Target**	**Unit Exposure (µg/lb ai)[1]**		**Maximum Application Rate[3]**	**Area Treated or Amount Handled Daily[4]**	**Non-Cancer**		**Cancer**	
		Dermal	**Inhalation**			**Inhalation**		**Commercial Applicator**	
		PPE[2]				**Dose (mg/kg/day)[5]**	**MOE[6]**	**Total LADD[7]**	**Cancer Risk Estimate[8]**
RTU (D): Shaker Can	Landscaping (plants/flowers)	4042000	17500	0.0025 lb ai/1 lb container	10 lbs	0.0055	1,700	0.0017	2E-05
	Livestock	4042000	17500	0.000031 lb ai/animal	400 animals	0.0027	3,500	0.00086	8E-06
	Domestic Animals	4042000	17500	0.00016 lb ai/animal	8 animals	0.00028	33,000	0.000089	9E-07
RTU (G): Shaker Can	Mounds/Nests	112	12.5	0.00156 lbs ai/mound	1000 mounds	0.00024	38,000	0.000012	1E-07
RTU (L): Spot-on	Domestic Animal	112000	Negligible exposure	0.006 ai/animal	8 animals	Negligible exposure	Negligible exposure	Negligible exposure	Negligible exposure
RTU (L): Trigger-spray Bottle	Livestock (Horses)	544000	3300	0.017 ai/animal	400 animals	0.018	540	0.0042	4E-05
	Domestic Animal	544000	3300	0.000538 lbs ai/bottle	8 bottles	0.00018	53,000	0.000042	4E-07
	Residential Indoor Surface (C&C)	3660	61.2	0.043 lb ai/bottle	8 bottles	0.00026	35,000	0.000029	3E-07
	Landscaping (plants/flowers)	3660	61.2			0.00026	35,000	0.000029	3E-07
RTU (PL): Aerosol Can	Military Aircraft (using warehouse as surrogate)	190000	1300	0.00441 lbs ai/can	4 cans	0.00029	33,000	0.000062	6E-07
	Domestic Animal	544000	3300	0.000538 lb ai/can	8 cans	0.00018	53,000	0.000042	4E-07
	Foundations/perimeter	190000	1300	0.035 lb ai/16 oz can		0.0046	2,100	0.00098	9E-06
	Residential Indoor Living Spaces	190000	1300	0.00438 lb ai/16 oz can		0.00057	16,000	0.00012	1E-06
	Residential Outdoor Spaces	190000	1300	0.007 lb ai/acre		0.00091	10,000	0.00020	2E-06
	Landscaping (plants/flowers)	190000	1300	0.0025 lb ai/6 oz can		0.00033	29,000	0.000070	7E-07
RTU (PL): Total-release Fogger	Warehouse	Negligible exposure	Negligible exposure	0.035 lbs ai/can	8 cans	Negligible exposure	Negligible exposure	Negligible exposure	Negligible exposure
RTU (S): Ear Tag	Livestock	Negligible exposure	Negligible exposure	0.0044 lbs ai/eartag	400 eartags	Negligible exposure	Negligible exposure	Negligible exposure	Negligible exposure
RTU (L):	Domestic Animals	2380000	480	0.0062	8 animals	0.000298	31,000	0.0018	2E-05

Table 8.1.2. Occupational Handler Non-Cancer and Cancer Exposure and Risk Estimates for Permethrin Non-Agricultural Uses.									
Exposure Scenario Formulation: Equipment	**Crop or Target**	**Unit Exposure (µg/lb ai)[1]**		**Maximum Application Rate[3]**	**Area Treated or Amount Handled Daily[4]**	**Non-Cancer**		**Cancer**	
		Dermal	**Inhalation**			**Inhalation**		**Commercial Applicator**	
		PPE[2]				**Dose (mg/kg/day)[5]**	**MOE[6]**	**Total LADD[7]**	**Cancer Risk Estimate[8]**
Wipe/Towelette	Livestock (Horses)	2380000	480	0.0062	25 animals	0.00093	10,000	0.0056	5E-05
Mixer/Loader/Applicator									
DF: Backpack	Christmas Tree Farm	58400	69.1	0.2 lb ai/acre	5 acres	0.00086	11,000	0.00092	9E-06
	Conifer Pine Seed Orchard	58400	69.1	0.016 lbs ai/gal	40 gallons	0.00055	17,000	0.00059	6E-06
DF: Manually-Pressurized Handwand	Christmas Tree Farm	100000	30	0.2 lb ai/acre	5 acres	0.00038	25,000	0.0015	1E-05
DF: Mechanically-Pressurized Handgun	Greenhouse Ornamentals	3500	120	0.2 lb ai/gal	1000 gallons	0.30	31	0.0027	3E-05
	Christmas Tree Farm	6050	8.68	0.2 ai/acre	125 acres	0.0027	3,500	0.0024	2E-05
L/EC: Backpack	Greenhouse Ornamentals	13200	140	0.037 lb ai/gal	40 gallons	0.0026	3,600	0.00039	4E-06
	Wildlife Management	58400	69.1	0.04 lbs ai/gal	40 gallons	0.0014	6,700	0.0015	1E-05
	Christmas Tree Farm	58400	69.1	0.2 lb ai/acre	5 acres	0.00086	11,000	0.00092	9E-06
	Forestry (ground directed)	8260	2.58	0.016 lb ai/gal	40 gallons	0.000021	450,000	0.000081	8E-07
	Forestry (foliar)	58400	69.1	0.016 lbs ai/gal	40 gallons	0.00055	17,000	0.00059	6E-06
	Landscaping (trees/shrubs)	58400	69.1	0.2 lbs ai/acre	5 acres	0.00086	11,000	0.00092	9E-06
	Landscaping (lawns/turf)	58400	69.1	0.04 lb ai/gal	40 gallons	0.0014	6,700	0.015	1E-04
	Structural (termiticide)	2510	30	0.0332 lbs ai/1000 sq ft	1000 linear ft	0.013	750	0.0017	2E-05
	Industrial/commercial (tires, rail yards, junk yards, etc.)	2510	30	0.0023 lb ai/gal	40 gallons	0.00056	17,000	0.000077	7E-07
	Livestock	2510	30	0.0023 lb ai/animal	400 animals	0.00035	27,000	0.000048	5E-07
	Poultry/livestock house/horse barn/feed lot	2510	30	0.113 lb ai/gal	40 gallons	0.0017	5,500	0.00024	2E-06
	Foundations/perimeter	8260	2.58	0.78 lb ai/gal	40 gallons	0.0010	9,300	0.0040	4E-05
	Aquatic Vector Control	8260	2.58	0.007 lb ai/acre	5 acres	0.0000011	8,300,000	0.0000044	4E-08

Table 8.1.2. Occupational Handler Non-Cancer and Cancer Exposure and Risk Estimates for Permethrin Non-Agricultural Uses.									
Exposure Scenario Formulation: Equipment	**Crop or Target**	**Unit Exposure (µg/lb ai)[1]**		**Maximum Application Rate[3]**	**Area Treated or Amount Handled Daily[4]**	**Non-Cancer**		**Cancer**	
		Dermal	**Inhalation**			**Inhalation**		**Commercial Applicator**	
		PPE[2]				**Dose (mg/kg/day)[5]**	**MOE[6]**	**Total LADD[7]**	**Cancer Risk Estimate[8]**
L/EC: Injector	Structural (termiticide)	1300	2.2	0.08 lb ai/gal	2000 gallons	0.0044	2,100	0.0033	3E-05
L/EC: Manually Pressurized Handwand	Greenhouse Ornamentals	100000	30	0.037 lb ai/gal	40 gallons	0.00056	17,000	0.0023	2E-05
	Wildlife Management	100000	30	0.04 lbs ai/gal	40 gallons	0.0006	16,000	0.0025	2E-05
	Christmas Tree farm	100000	30	0.2 lb ai/acre	5 acres	0.00038	25,000	0.0015	1E-05
	Landscaping (trees/shrubs)	100000	30	0.02 lbs ai/acre	125 acres	0.0094	1,000	0.038	4E-04
	Landscaping (lawns/turf)	100000	30	0.04 lb ai/gal	40 gallons	0.0006	16,000	0.025	2E-04
	Industrial/commercial (tires, rail yards, junk yards, etc.)	100000	30	0.037 lb ai/gal	40 gallons	0.00056	17,000	0.0023	2E-05
	Food Handling Establishment (broadcast)	29000	1100	0.037 lbs ai/gal	40 gallons	0.020	460	0.0014	1E-05
	Food Handling Establishment (C&C)	29000	1100			0.020	460	0.0014	1E-05
	Warehouse (broadcast)	29000	1100	0.037 lbs ai/gal	40 gallons	0.020	460	0.0014	1E-05
	Warehouse (C&C)	29000	1100			0.020	460	0.014	1E-04
	Poultry/livestock house/horse barn/feed lot	100000	30	0.113 lb ai/gal	40 gallons	0.0017	5,500	0.0069	7E-05
	Livestock	100000	30	0.0023 lb ai/animal	400 animals	0.00035	27,000	0.0014	1E-05
	Foundations/perimeter	100000	30	0.78 lb ai/gallon	40 gallons	0.012	800	0.048	5E-04
	Mounds/Nests	100000	30	0.08 lbs ai/mound	1000 mounds	0.03	310	0.12	1E-03
	Interior Landscaping	100000	30	0.041 lb ai/gallon	40 gallons	0.00062	15,000	0.0025	2E-05
L/EC: Mechanically-Pressurized Handgun	Golf course (fairways, tees, greens)	1140	1.9	0.87 lb ai/acre	5 acres	0.000094	100,000	0.000072	7E-07
	Christmas Tree farm	6050	8.68	0.2 lb ai/acre	125 acres	0.0027	3,500	0.0024	2E-05
	Landscaping (Lawns/Turf)	1140	1.9	0.87 lb ai/acre	5 acres	0.00010	91,000	0.000079	8E-07
	Livestock	1800	79	0.00027 lbs ai/animal	400 animals	0.00011	88,000	0.0000069	7E-08

Table 8.1.2. Occupational Handler Non-Cancer and Cancer Exposure and Risk Estimates for Permethrin Non-Agricultural Uses.									
Exposure Scenario Formulation: Equipment	**Crop or Target**	**Unit Exposure (µg/lb ai)[1]**		**Maximum Application Rate[3]**	**Area Treated or Amount Handled Daily[4]**	**Non-Cancer**		**Cancer**	
		Dermal	**Inhalation**			**Inhalation**		**Commercial Applicator**	
		PPE[2]				**Dose (mg/kg/day)[5]**	**MOE[6]**	**Total LADD[7]**	**Cancer Risk Estimate[8]**
	Aquatic Vector Control	6050	8.68	0.007 lb ai/acre	5 acres	0.0000038	2,500,000	0.0000034	3E-08
WP: Backpack	Conifer Pine Seed Orchard	58400	69.1	0.016 lbs ai/gal	40 gallons	0.00055	17,000	0.00059	6E-06
WP: Mechanically-Pressurized Handgun	Greenhouse Ornamentals	3500	120	0.2 lbs ai/gal	1000 gallons	0.3	31	0.0027	3E-05
WSP: Backpack	Christmas Tree farm	58400	69.1	0.2 lb ai/acre	5 acres	0.00086	11,000	0.00092	9E-06
WSP: Manually-Pressurized Handwand		100000	30	0.2 lb ai/acre	5 acres	0.00038	25,000	0.0015	1E-05
WSP: Mechanically-Pressurized Handgun		6050	8.68	0.2 lb ai/acre	125 acres	0.0027	3,500	0.0024	2E-05
Loader/Applicator									
G: Belly Grinder	Landscaping (Lawns/Turf)	10000	62	0.65 lb ai/acre	1 acre	0.000504	19,000	0.00012	1E-06
G: Cup	Mounds/Nests	112	12.5	0.00156 lb ai/mound	1000 mounds	0.000244	38,000	0.00016	2E-06
Paint/Stain: Airless Sprayer	Structural (warehouses, FHE, home bathrooms)	42600	560	0.04 lbs ai/gal	40 gallons	0.0112	840	0.0015	1E-05
	Structural (bridges, shipyards, home decks, foundations)	42600	560			0.0112	840	0.0015	1E-05
Paint/Stain: Brush/Roller	Structural (warehouses, FHE, home bathrooms)	180000	280	0.04 lbs ai/gal	5 gallons	0.0007	13,000	0.00058	6E-06
	Structural (bridges, shipyards, home decks, foundations)	180000	280			0.0007	13,000	0.00058	6E-06

1 Based on the "Occupational Pesticide Handler Unit Exposure Surrogate Reference Table" (http://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/occupational-pesticide-handler-exposure-data); Level of mitigation: Baseline PPE with no gloves and no respirator, Eng. Controls.
2 PPE = Baseline (i.e., long sleeved shirt, long pants, shoes plus socks) no gloves, and no respirator unless otherwise indicated
3 Based on registered uses listed in Appendix A, Tables 4.1 and 4.2.
4 Exposure Science Advisory Council Policy #9.1.
5 Inhalation Dose = Dermal Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) × Application Rate (lb ai/acre or gal) × Area Treated or Amount Handled Daily (A or gal/day) ÷ BW (kg).
6 Inhalation MOE = Inhalation NOAEL (mg/kg/day) ÷ Inhalation Dose (mg/kg/day).
7 Total LADD = Dermal LADD + Inhalation LADD
8 Total Cancer Risk Estimate = Total LADD × Q_1^*, where Q_1^* = **9.567 x 10-3** $(mg/kg/day)^{-1}$

Table 8.1.3. Occupational Handler Non-Cancer Exposure and Risk Estimates for Permethrin (Seed Treatment).				
Crop or Target	**Inhalation Unit Exposure[1] (mg/lb ai)**	**Maximum Application Rate[2]**	**Amount of Seed Treated (T) or Planted (P) Per Day[3]**	**Inhalation (LOC = 30)**
	[Level of PPE]	**(lb ai/lb seed)**	**(lb seed/day)**	**MOE[5]**
Mixer/Loader				
Corn (field, pop, sweet)	0.0012 [No R]	0.0037	339,500 (T)	500
Soybeans		0.0031	281,250 (T)	720
Planters				
Corn (field, pop, sweet)	0.0034 [No R]	0.0037	8,800 (P)	6,800
Soybeans		0.0031	33,400 (P)	2,100

1 Based on the Science Advisory Council for Exposure Policy 14 (May 2003); Level of mitigation: No R = No Respirator, PF5 Respirator, and PF10 Respirator.
2 Based on registered label (Reg. No. 400-560). Summarized in Appendix A, Table 4.1.
3 Based on highest pounds of seed treated per day (corn and soybean) from HED Exposure Science Advisory Council Interim Policy 15.1.
4 Inhalation MOE = Inhalation HED (mg/kg/day) ÷ Inhalation Dose (mg/kg/day). Inhalation Dose = Inhalation Unit Exposure (mg/lb ai) × Application Rate (lb ai/lb of seed) × Amount Handled Daily (lb seed treated or planted/day) ÷ BW (80 kg).

APPENDIX F. Summary of Residential Non-Cancer Algorithms

1.0 Residential Handlers

1.1 Residential Handler Exposure Calculations

1.1.1 Turf, Gardens and Trees, Indoor Environments

Dermal and Inhalation Handler Exposure Algorithm
Daily dermal and inhalation exposure (mg/day) for residential pesticide handlers, for a given formulation-application method combination, is estimated by multiplying the formulation-application method-specific unit exposure by an estimate of the amount of active ingredient handled in a day, using the equation below:

$$E = UE * AR * A$$

where:

E = exposure (mg/day);
UE = unit exposure (mg/lb ai);
AR = application rate (e.g., lb ai/ft^2, lb ai/gal); and
A = area treated or amount handled (e.g., ft^2/day, gal/day).

1.1.2 Treated Pets

Dermal and Inhalation Handler Exposure Algorithm
Daily dermal and inhalation exposure (mg/day) for residential pesticide handlers, for a given formulation-application method combination, is estimated by multiplying the formulation-application method-specific unit exposure by an estimate of the amount of active ingredient handled in a day, using the equation below:

$$E = UE * AR * A$$

where:

E = exposure (mg/day);
UE = unit exposure (mg/lb ai);
AR = application rate (e.g., lb ai/ft^2, lb ai/gal); and
A = number of animals treated per day.

1.1.3 Outdoor Fogging/Misting Systems

1.1.3.1 Outdoor Aerosol Space Sprays (OASS)

Dermal and Inhalation Handler Exposure Algorithm

Daily dermal and inhalation exposure (mg/day) for residential pesticide handlers is estimated by multiplying a unit exposure appropriate for the formulation and application method by an estimate of the amount of active ingredient handled in a day using the equation below:

$$E = UE * AR$$

where:

E = exposure (mg/day);
UE = unit exposure (mg/lb ai); and
AR = application rate (lb ai/day).

The application rate can be calculated as follows:

$$AR = A_{product} * A.I. * CF1 * N$$

where:

AR = application rate (lb ai/ day);
$A_{product}$ = amount of product in 1 can (oz or g/can);
A.I. = percent active ingredient in product (% ai);
CF1 = weight conversion factor (1 lb/16 oz or 1 lb/454 g); and
N = number of cans used in one application (cans/day).

Alternatively, if the aerosol can contents are expressed as a volume in milliliters, the application rate for use in the exposure assessment can be calculated as follows:

$$AR = A_{product} * A.I. * CF1 * D_{product} * N$$

where:

AR = application rate (lb ai/ day);
$A_{product}$ = amount of product in 1 can (mL/can);
A.I. = percent active ingredient in product (% ai);
CF1 = weight conversion factor (1 lb/454 g);
$D_{product}$ = density of product (g/mL); and
N = number of cans used in one day (cans/day).

1.1.3.2 Outdoor Residential Misting Systems

Dermal and Inhalation Handler Exposure Algorithm
Daily dermal and inhalation exposure (mg/day) for residential pesticide handlers is estimated for a given formulation-application method combination by multiplying the formulation-application

method-specific unit exposure by an estimate of the amount of active ingredient handled in a day, using the equation below:

$$E = UE * AR$$

where:

E = exposure (mg/day);
UE = unit exposure (mg/lb ai); and
AR = application rate (lb ai/day).

The application rate can be calculated as follows:

$$AR = V_D * N * DR * A.I. * D_{H2O}$$

where:

AR = application rate per day (lb ai/ day);
V_D = volume of the drum of the misting system (gallons/drum);
N = number of drums filled per day (drums/day)
DR = dilution rate (volume product /volume total solution);
A.I. = percent active ingredient in product (%); and
D_{H2O} = water density (lb/gal).

1.1.3.3 Animal Barn Misting Systems

Dermal and Inhalation Handler Exposure Algorithm
Daily dermal and inhalation exposure (mg/day) for residential pesticide handlers, for a given formulation-application method combination, is estimated by multiplying the formulation-application method-specific unit exposure by an estimate of the amount of active ingredient handled in a day, using the equation below:

$$E = UE * AR$$

where:

E = exposure (mg/day);
UE = unit exposure (mg/lb ai); and
AR = application rate (lb ai/day).

The application rate can be calculated as follows:

$$AR = V_D * N * DR * A.I. * D_{H2O}$$

where:

AR = application rate per day (lb ai/ day);
V_D = volume of the drum of the misting system (gallons/drum);
N = number of drums filled per day (drums/day);
DR = dilution rate (volume of product/volume of total solution);
A.I. = percent active ingredient in product (%); and
D_{H2O} = water density (lb/gal).

1.1.4 Insect Repellents

Dermal and Inhalation Handler Exposure Algorithm
Daily dermal and inhalation exposure (mg/day) for residential pesticide handlers, for a given formulation-application method combination, is estimated by multiplying the formula-application method-specific unit exposure by an estimate of the amount of active ingredient handled in a day, using the equation below:

$$E = UE * AR$$

where:

E = exposure (mg/day);
UE = unit exposure (mg/lb ai);
AR = application rate (e.g., lb ai/day)

The application rate can be calculated as follows:

$$AR = A.I * W * N$$

where:

AR = application rate per day (lb ai/ day);
A.I. = % active ingredient in product (by weight);
W = weight of product unit (e.g., 12 oz aerosol can)
N = number of product units used per day (e.g. cans/day)

1.1.5 Treated Paints and Preservatives

Dermal and Inhalation Handler Exposure Algorithm
Daily dermal and inhalation exposure (mg/day) for residential pesticide handlers, for a given formulation-application method combination, is estimated by multiplying the formulation-application method-specific unit exposure by an estimate of the amount of active ingredient handled in a day, using the equation below:

$$E = UE * AR * N$$

where:

E = exposure (mg/day);
UE = unit exposure (mg/lb ai);
AR = application rate (e.g., lbs a.i./can); and
A = number of cans paint used per exposure day (cans/day).

The application rate can be calculated as follows:

$$AR = V * \rho * WF * CF1$$

where:

AR = Mass of active ingredient applied per paint can (lbs ai/can);
V = Volume of paint contained in each can (mL/can);
ρ = Paint density (g/mL);
WF = Weight fraction of a.i. in treated paint/preservative (% ai w/w); and
CF1 = Gram-to-pound conversion factor (2.2×10^{-3} lbs/g).

1.2 Residential Handler Dose Calculations

Dermal and/or inhalation absorbed doses normalized to body weight are calculated as:

$$D = E * AF / BW$$

where:

D = dose (mg/kg-day);
E = exposure (mg/day);
AF = absorption factor (dermal and/or inhalation); and
BW = body weight (kg).

2.0 Residential Post-application

2.1 Turf/Physical Activities on Turf

Post-application Hand-to-Mouth Exposure Algorithm– Physical Activities on Turf
Exposure from hand-to-mouth activity is calculated as follows (based on the algorithm utilized in the SHEDS-Multimedia model):

$$E = [HR * (F_M * SA_H) * (ET * N\_Replen) * (1- (1- SE)^{(Freq\_HtM/N-Replen)})]$$

where:

E = exposure (mg/day);

HR = hand residue loading (mg/cm^2);
FM = fraction hand surface area mouthed / event (fraction/event);
SAH = typical surface area of one hand (cm^2);
ET = exposure time (hr/day);
N_Replen = number of replenishment intervals per hour (intervals/hour);
SE = saliva extraction factor (i.e., mouthing removal efficiency); and
Freq_HtM = number of hand-to-mouth contacts events per hour (events/hour).

and

$$HR = \frac{Fai_{hands} * DE}{SA_H * 2}$$

where:

HR = hand residue loading (mg/cm^2);
Fai_{hands} = fraction ai on hands compared to total surface residue from dermal transfer coefficient study (unitless);
DE = dermal exposure (mg); and
SA_H = typical surface area of one hand (cm^2).

Dose, normalized to body weight, is calculated as:

$$D = \frac{E}{BW}$$

where:

D = dose (mg/kg-day);
E = exposure (mg/day); and
BW = body weight (kg).

Table A-X: Turf (Physical Activities) – Inputs for Residential Post-application Hand-to-Mouth Exposure

Algorithm Notation	Exposure Factor (units)		Point Estimate(s)
Fai_{hands}	Fraction of ai on hands from dermal transfer coefficient study (unitless)	Liquid formulations	0.06
		Granular formulations	0.027
DE	Dermal exposure (mg)		Calculated
SA_H	Typical surface area of one hand (cm^2), children 1 < 2 years old		150
AR	Application rate (mass active ingredient per unit area)		**[input]**
HR	Residue available on the hands (mg/cm^2)		Calculated via (DE * Fai_{hands})/SA_H

Table A-X: Turf (Physical Activities) – Inputs for Residential Post-application Hand-to-Mouth Exposure			
Algorithm Notation	**Exposure Factor (units)**		**Point Estimate(s)**
F_M	Fraction hand surface area mouthed (fraction/event)		0.127
N_Replen	Replenishment intervals per hour (intervals/hr)		4
ET	Exposure time (hrs/day)		1.5
SE	Saliva extraction factor (unitless)		0.48
Freq_HtM	Hand-to-mouth events per hour (events/hr)		13.9
BW	Body Weight (kg)	Children 1 < 2 years old	11

Post-application Object-to-Mouth Exposure Algorithm– Physical Activities on Turf

Exposure from object-to-mouth activity is calculated as follows (based on the algorithm utilized in SHEDS-Multimedia):

$$E = [OR^* CF1 * SAM_O * (ET * N\_Replen) * (1- (1- SE_O)^{(Freq\_OtM/N\_Replen)})]$$

where:

E = exposure (mg/day);
OR = chemical residue loading on the object on day "t" (ug/cm^2);
CF1 = weight unit conversion factor (0.001 mg/µg);
SAM_O = area of the object surface that is mouthed (cm^2/event);
ET = exposure time (hr/day);
N_Replen = number of replenishment intervals per hour (intervals/hour);
SE_O = saliva extraction factor (i.e., mouthing removal efficiency); and
Freq_OtM = number of object-to-mouth contact events per hour (events/hour).

and

$$OR = AR * F_O * CF2 * CF3$$

where:

OR = chemical residue loading on the object (µg/cm^2);
AR = application rate (lbs ai/ft^2 or lb ai/acre);
F_O = fraction of residue available on the object (unitless);
CF2 = weight unit conversion factor (4.54 x 10^8 µg/lb); and
CF3 = area unit conversion factor (1.08 x 10^{-3} ft^2/cm^2 or 2.47 x 10^{-8} acre/cm^2).

Dose, normalized to body weight, is calculated as:

$$D = \frac{E}{BW}$$

where:

D	=	dose (mg/kg-day);
E	=	exposure (mg/day); and
BW	=	body weight (kg).

Table A-X: Turf (Physical Activities) – Inputs for Residential Post-application Object-to-Mouth Exposure			
Algorithm Notation	**Exposure Factor (units)**		**Point Estimate(s)**
AR	Application rate (to turf) (mass active ingredient per unit area)		**[input]**
F_O	Fraction of AR as OR following application [1]		0.01
SAM_O	Surface area of object mouthed (cm^2/event)		10
N_Replen	Replenishment intervals per hour (intervals/hour)		4
SE_O	Saliva extraction factor (fraction)		0.48
ET	Exposure time (hours per day)		1.5
Freq_OtM	Object-to-mouth events per hour (events/hr)		8.8
BW	Body Weight (kg)	Children 1 < 2 years old	11
[1] This SOP assumes that all of the residue on the turf could be transferred to the object (e.g., object residue is equal to turf transferable residue).			

Post-application Incidental Soil Ingestion Exposure Algorithm– Physical Activities on Turf

Exposure from incidental soil ingestion is calculated as follows:

$$E = SRt * SIgR * CF1$$

where:
E = exposure (mg/day);
SRt = soil residue on day "t" (µg/g);
SIgR = ingestion rate of soil (mg/day); and
CF1 = weight unit conversion factor (1×10^{-6} g/µg).

and

$$SRt = AR * FS * (1-F_D)^t * CF2 * CF3 * CF4$$

where:

SR_t = soil residue on day "t" (µg/g);
AR = application rate (lbs ai/ft^2 or lb ai/acre);
FS = fraction of ai available in uppermost cm of soil (fraction/cm);

F_D = fraction of residue that dissipates daily (unitless);
T = post-application day on which exposure is being assessed;
CF2 = weight unit conversion factor (4.54×10^8 µg/lb);
CF3 = area unit conversion factor (1.08×10^{-3} ft^2/cm^2 or 2.47×10^{-8} acre/cm^2); and
CF4 = soil volume to weight unit conversion factor (0.67 cm^3/g soil).

Dose, normalized to body weight, are calculated as:

$$D = \frac{E}{BW}$$

where:

D	=	dose (mg/kg-day);
E	=	exposure (mg/day); and
BW	=	body weight (kg).

Table A-X: Turf (Physical Activities) – Inputs for Residential Post-application Incidental Soil Ingestion Exposure			
Algorithm Notation	**Exposure Factor (units)**		**Point Estimate(s)**
AR	Application rate (mass active ingredient per unit area)		**[input]**
FS	Fraction of AR available in uppermost 1 cm of soil (unitless)		1
F_D	Daily residue dissipation (fraction)		0.1
SIgR	Soil ingestion rate (mg/day)		50
BW	Body weight (kg)	Children 1 < 2 years old	11

<u>Post-application Episodic Granular Ingestion Exposure Algorithm– Physical Activities on Turf</u>
Exposure from incidental ingestion of pesticide pellets or granules is calculated as follows:

$$E = GIgR * FD * CF1$$

where:
E = exposure (mg/day);
GIgR = ingestion rate of dry pesticide formulation (g/day);
FD = fraction of ai in dry formulation (unitless); and
CF1 = weight unit conversion factor (1,000 mg/g).

Dose, normalized to body weight, are calculated as:

$$D = \frac{E}{BW}$$

where:

D	=	dose (mg/kg-day);

E = exposure (mg/day); and
BW = body weight (kg).

Table A-X: Turf (Physical Activities) – Inputs for Residential Post-application Episodic Granular Ingestion Exposure			
Algorithm Notation	**Exposure Factor (units)**		**Point Estimate(s)**
F_D	Fraction of active ingredient in dry formulation		**[input]**
AR	Application rate (lbs/A or lbs/1,000 ft^2)		**[input]**
GIgR	Granule ingestion rate per day (g/day) [1]		0.3
BW	Body Weight (kg)	Children 1 < 2 years old	11
[1] See discussion below on how this value may be adjusted if product specific information is available.			

2.2 Outdoor Fogging/Misting Systems

2.2.1 Outdoor Aerosol Space Sprays (OASS)

Post-application Inhalation Exposure Algorithm

The following algorithm is used to determine post-application inhalation exposure to outdoor aerosol space sprays:

$$E = \frac{IR * AR}{Q}$$

where:

E = exposure (mg/day);
IR = inhalation rate (m^3/hour);
AR = application rate (mg ai/day); and
Q = airflow through the treated area (m^3/hour).

The airflow through the treated space can be calculated as follows:

$$Q = AV * CF1 * CF2 * A_{cross\text{-}section}$$

where:

Q = airflow through treated space (m^3/hr);
AV = air velocity (m/s);
CF1 = time unit conversion factor (60 seconds/1 minute);
CF2 = time unit conversion factor (60 minutes / hour); and
$A_{cross\text{-}section}$ = cross-section of outdoor space treated (m^2).

Application rate can be calculated as follows:

$$AR = A_{product} * A.I. * CF1 * N$$

where:

AR = application rate (mg ai/ day);
$A_{product}$ = amount of product in 1 can (oz or g/can);
A.I. = percent active ingredient in product (% ai);
CF1 = weight conversion factor (28,350 mg/oz or 1,000 mg/g); and
N = number of cans applied per day in one application (cans/day).

Alternatively, if the aerosol can contents are expressed as a volume in milliliters, the application rate for use in the exposure assessment can be calculated as follows:

$$AR = A.I. * A_{product} * CF * D_{product} * N$$

where:

AR = application rate (mg ai/day);
A.I. = percent active ingredient in product (% ai);
$A_{product}$ = amount of product per can (mL/can);
CF = conversion factor to convert grams to milligrams (1,000 mg/1 g);
$D_{product}$ = density of product (g/mL); and
N = number of cans applied per day in one application (cans/day).

Absorbed inhalation dose normalized to body weight is calculated as:

$$D = \frac{E * AF}{BW}$$

where:

D = dose (mg/kg-day);
E = exposure (mg/day);
AF = absorption factor (inhalation); and
BW = body weight (kg).

Table A-X: Outdoor Aerosol Space Sprays –Inputs for Residential Post-application Inhalation Exposure

Algorithm Notation	Exposure Factor (units)	Point Estimate(s)
AR	Application rate (mg ai/ day)	**[input]**
$A_{cross\text{-}section}$	Cross sectional area of area treated (m^2)	15
AV	Air velocity (m/s)	0.1
Q	Airflow through treated area (m^3/hr)	5,400

N	Number of cans applied per day in one application (cans/day)		1
$D_{product}$	Density of product (g/mL)	Water-based products	1.0
		Solvent-based products	0.8
A.I.	Percent ai in product (%)		**[input]**
$A_{product}$	Amount of product (mL/can)		**[input]**
IR	Inhalation rate (m^3/hour)	Adult	0.64
		Children (1 < 2 years old)	0.33
BW	Body Weight (kg)	Adult	80
		Children (1 < 2 years old)	11

Post-application Hand-to-Mouth Exposure Algorithm

Exposure from hand-to-mouth activity is calculated as follows (based on the algorithm utilized in the SHEDS-Multimedia model):

$$E = [HR * (F_M * SA_H) * (ET * N\_Replen) * (1- (1- SE)^{(Freq\_HtM/N-Replen)})]$$

where:

E = exposure (mg/day);
HR = hand residue loading (mg/cm^2);
FM = fraction hand surface area mouthed / event (fraction/event);
SAH = typical surface area of one hand (cm^2);
ET = exposure time (hr/day);
N_Replen = number of replenishment intervals per hour (intervals/hour);
SE = saliva extraction factor (i.e., mouthing removal efficiency); and
Freq_HtM = number of hand-to-mouth contacts events per hour (events/hour).

and

$$HR = \frac{Fai_{hands} * DE}{SA_H * 2}$$

where:

HR = hand residue loading (mg/cm^2);
Fai_{hands} = fraction ai on hands compared to total surface residue from dermal transfer coefficient study (unitless);
DE = dermal exposure (mg); and
SA_H = typical surface area of one hand (cm^2).

Dose, normalized to body weight, is calculated as:

$$D = \frac{E}{BW}$$

where:

D = dose (mg/kg-day);
E = exposure (mg/day); and
BW = body weight (kg).

Table A-X: Outdoor Aerosol Space Sprays – Inputs for Residential Post-application Hand-to-Mouth Exposure			
Algorithm Notation	**Exposure Factor (units)**		**Point Estimate(s)**
Fai_{hands}	Fraction of ai on hands from dermal transfer coefficient study (unitless)		0.06
DE	Dermal exposure (mg)		Calculated
SA_H	Typical surface area of one hand (cm^2), children 1 < 2 years old		150
AR	Application rate (mass active ingredient per unit area)		**[input]**
HR	Residue available on the hands (mg/cm^2)		Calculated via (DE * Fai_{hands})/SA_H
F_M	Fraction hand surface area mouthed (fraction/event)		0.127
N_Replen	Replenishment intervals per hour (intervals/hr)		4
ET	Exposure time (hrs/day)		1.5
SE	Saliva extraction factor (unitless)		0.48
Freq_HtM	Hand-to-mouth events per hour (events/hr)		13.9
BW	Body Weight (kg)	Children 1 < 2 years old	11

Post-application Object-to-Mouth Exposure Algorithm

Exposure from object-to-mouth activity is calculated as follows (based on the algorithm utilized in SHEDS-Multimedia):

$$E = [OR^* CF1 * SAM_O * (ET * N\_Replen) * (1- (1- SE_O)^{(Freq\_OtM/N\_Replen)})]$$

where:

E = exposure (mg/day);
OR = chemical residue loading on the object on day "t" (ug/cm^2);
CF1 = weight unit conversion factor (0.001 mg/µg);
SAM_O = area of the object surface that is mouthed (cm^2/event);
ET = exposure time (hr/day);

N_Replen = number of replenishment intervals per hour (intervals/hour);
SE_O = saliva extraction factor (i.e., mouthing removal efficiency); and
Freq_OtM = number of object-to-mouth contact events per hour (events/hour).

and

$$OR = AR * F_O * CF2 * CF3$$

where:

OR = chemical residue loading on the object (µg/cm^2);
AR = application rate (lbs ai/ft^2 or lb ai/acre);
F_O = fraction of residue available on the object (unitless);
CF2 = weight unit conversion factor (4.54 x 10^8 µg/lb); and
CF3 = area unit conversion factor (1.08 x 10^{-3} ft^2/cm^2 or 2.47 x 10^{-8} acre/cm^2).

Dose, normalized to body weight, is calculated as:

$$D = \frac{E}{BW}$$

where:

D	=	dose (mg/kg-day);
E	=	exposure (mg/day); and
BW	=	body weight (kg).

Table A-X: Outdoor Aerosol Space Sprays – Inputs for Residential Post-application Object-to-Mouth Exposure

Algorithm Notation	Exposure Factor (units)		Point Estimate(s)
AR	Application rate (to turf) (mass active ingredient per unit area)		**[input]**
F_O	Fraction of AR as OR following application [1]		0.01
SAM_O	Surface area of object mouthed (cm^2/event)		10
N_Replen	Replenishment intervals per hour (intervals/hour)		4
SE_O	Saliva extraction factor (fraction)		0.48
ET	Exposure time (hours per day)		1.5
Freq_OtM	Object-to-mouth events per hour (events/hr)		8.8
BW	Body Weight (kg)	Children 1 < 2 years old	11

[1] This SOP assumes that all of the residue on the turf could be transferred to the object (e.g., object residue is equal to turf transferable residue).

Post-application Incidental Soil Ingestion Exposure Algorithm

Exposure from incidental soil ingestion is calculated as follows:

$$E = SRt * SIgR * CF1$$

where:
E = exposure (mg/day);
SRt = soil residue on day "t" (µg/g);
SIgR = ingestion rate of soil (mg/day); and
CF1 = weight unit conversion factor (1 x 10^{-6} g/µg).

and

$$SRt = AR * FS * (1-F_D)^t * CF2 * CF3 * CF4$$

where:

SR_t = soil residue on day "t" (µg/g);
AR = application rate (lbs ai/ft^2 or lb ai/acre);
FS = fraction of ai available in uppermost cm of soil (fraction/cm);
F_D = fraction of residue that dissipates daily (unitless);
T = post-application day on which exposure is being assessed;
CF2 = weight unit conversion factor (4.54 x 10^8 µg/lb);
CF3 = area unit conversion factor (1.08 x 10^{-3} ft^2/cm^2 or 2.47 x 10^{-8} acre/cm^2); and
CF4 = soil volume to weight unit conversion factor (0.67 cm^3/g soil).

Dose, normalized to body weight, are calculated as:

$$D = \frac{E}{BW}$$

where:

D	=	dose (mg/kg-day);
E	=	exposure (mg/day); and
BW	=	body weight (kg).

Table A-X: Outdoor Aerosol Space Sprays – Inputs for Residential Post-application Incidental Soil Ingestion Exposure

Algorithm Notation	Exposure Factor (units)		Point Estimate(s)
AR	Application rate (mass active ingredient per unit area)		**[input]**
FS	Fraction of AR available in uppermost 1 cm of soil (unitless)		1
F_D	Daily residue dissipation (fraction)		0.1
SIgR	Soil ingestion rate (mg/day)		50
BW	Body weight (kg)	Children 1 < 2 years old	11

2.2.2 Outdoor Residential Misting Systems

Post-Application Inhalation Exposure Algorithm

The following algorithm is used to determine post-application inhalation exposure from ORMS:

$$E = \frac{IR * C_0 * V}{Q}\left[\text{int}(ET \cdot PR) + \frac{(1 - R^{frac(ET \cdot PR)})}{(1 - R)}\right]$$

where:

E	= exposure (mg/day);
IR	= inhalation rate (m^3/hr);
C_0	= initial air concentration (mg/m^3);
V	= volume of treated space (m^3);
Q	= airflow (m^3/hr);
ET	= exposure time (hours/day);
PR	= pulse rate (spray events/hr);
frac(ET·PR)	= fraction portion of the product of the exposure time (ET) and the pulse rate (PR);
int(ET·PR)	= integer (i.e., whole number) portion of the product of the exposure time (ET) and the pulse rate (PR).
R	$= e^{-\frac{Q}{V}T_{BA}}$
T_{BA}	= time between application events (i.e., the inverse of the pulse rate, or 1/PR).

The airflow in the patio/backyard is determined as follows:

$$Q = AV * CF1 * CF2 * A_{cross\text{-}section}$$

where:

Q	= airflow through treated space (m^3/hr);
AV	= air velocity (m/s);
CF1	= time unit conversion factor (60 seconds/1 minute);
CF2	= time unit conversion factor (60 minutes/ hour); and
$A_{cross\text{-}section}$	= cross-section of outdoor space treated (m^2).

If chemical-specific data are available, air concentration is the air concentration at time 0. If data are not available, then the initial air concentration can be calculated using the following formula:

$$C_0 = AR * CF1 * CF2$$

where:

C_0	= initial air concentration (mg/m^3);
AR	= application rate per spray event (lbs ai/ft^3);

CF1 = weight unit conversion factor (454,000 mg/lb); and
CF2 = volume unit conversion factor (35.3 ft^3/ 1.0 m^3).

If application rates are given on the label, these rates should be used. Application rates are typically given in ounces of solution per 1000 ft^3 per spray event. The following equation can be used to convert this rate to pounds ai per ft^3:

$$AR = \frac{AR_{label} * A.I. * CF * D_{H2O}}{V_{NC}}$$

where:

AR = application rate per spray (lb ai/ ft^3);
AR_{label} = application rate on label (given as ounces per 1000 ft^3) (oz);
A.I. = percent active ingredient in product (%);
CF = volume unit conversion factor (1 gallon/128 ounces);
D_{H2O} = water density (lb/gal); and
V_{NC} = nozzle coverage volume (as stated on label) (typically 1000 ft^3, or as otherwise stated on the product label).

If application rate is not given on the label, it can be calculated as follows:

$$AR = \frac{A.I. * DR * GPM * SD * D_{H2O}}{V_{NC}}$$

where:

AR = application rate per spray (lb ai/ft^3);
A.I. = percent active ingredient in product (%);
DR = dilution rate (volume of product/volume total solution);
GPM = nozzle flowrate (gal/min);
SD = spray duration (min);
D_{H2O} = water density (lb/gal); and
V_{NC} = nozzle coverage volume (ft^3).

Absorbed inhalation dose normalized to body weight is calculated as:

$$D = \frac{E * AF}{BW}$$

where:

D = dose (mg/kg-day);
E = exposure (mg/day);
AF = absorption factor (inhalation); and
BW = body weight (kg).

Table A-X: Outdoor Residential Misting Systems – Inputs for Residential Post-application Inhalation Exposure			
Algorithm Notation	**Exposure Factor (units)**		**Point Estimate(s)**
AR	Application rate per spray event (lb ai/1000 ft^3)		**[input]**
PR	Pulse Rate (sprays/hr)		1 (unless otherwise specified on label)
DR	Dilution Rate (volume product/volume total solution)		**[input]**
GPM	Nozzle flowrate (gal/min)		0.014
SD	Spray duration (min)		1
D_{H2O}	Water density (lb/gal)		8.34
V_{NC}	Nozzle coverage volume (ft^3)		1,000 ft^3 per nozzle
V	Volume of treated space (m^3)		90.6
Q	Airflow (m^3/hr)		5,400
AV	Air velocity (m/s)		0.1
C_0	Initial air concentration (mg/m^3)		Calculated; concentration at time "0"
$A_{cross\text{-}section}$	Cross sectional area of area treated (m^2)		15 m^2
ET	Exposure time (hours/day)	Adult	2.3
		Children 1 < 2 years old	2.3
IR	Inhalation rate (m^3/hour)	Adult	0.64
		Children 1 < 2 years old	0.33
BW	Body weight (kg)	Adult	80
		Children 1 < 2 years old	11

Post-application Hand-to-Mouth Exposure Algorithm

Exposure from hand-to-mouth activity is calculated as follows (based on the algorithm utilized in the SHEDS-Multimedia model):

$$E = [HR * (F_M * SA_H) * (ET * N\_Replen) * (1- (1- SE)^{(Freq\_HtM/N\text{-}Replen)})]$$

where:

E = exposure (mg/day);
HR = hand residue loading (mg/cm^2);
F_M = fraction hand surface area mouthed / event (fraction/event);

SA_H = typical surface area of one hand (cm^2);
ET = exposure time (hr/day);
N_Replen = number of replenishment intervals per hour (intervals/hour);
SE = saliva extraction factor (i.e., mouthing removal efficiency); and
Freq_HtM = number of hand-to-mouth contacts events per hour (events/hour).

and

$$HR = \frac{Fai_{hands} * DE}{SA_H * 2}$$

where:

HR = hand residue loading (mg/cm^2);
Fai_{hands} = fraction ai on hands compared to total surface residue from dermal transfer coefficient study (unitless);
DE = dermal exposure (mg); and
SA_H = typical surface area of one hand (cm^2).

Dose, normalized to body weight, is calculated as:

$$D = \frac{E}{BW}$$

where:

D	= dose (mg/kg-day);
E	= exposure (mg/day); and
BW	= body weight (kg).

Table A-X: Outdoor Residential Misting Systems – Inputs for Residential Post-application Hand-to-Mouth Exposure

Algorithm Notation	Exposure Factor (units)	Point Estimate(s)
Fai_{hands}	Fraction of ai on hands from dermal transfer coefficient study (unitless)	0.06
DE	Dermal exposure (mg)	Calculated
SA_H	Typical surface area of one hand (cm^2), children 1 < 2 years old	150
AR	Application rate (mass active ingredient per unit area)	**[input]**
HR	Residue available on the hands (mg/cm^2)	Calculated via (DE * Fai_{hands})/SA_H
F_M	Fraction hand surface area mouthed (fraction/event)	0.127
N_Replen	Replenishment intervals per hour (intervals/hr)	4

Table A-X: Outdoor Residential Misting Systems – Inputs for Residential Post-application Hand-to-Mouth Exposure			
Algorithm Notation	**Exposure Factor (units)**		**Point Estimate(s)**
ET	Exposure time (hrs/day)		1.5
SE	Saliva extraction factor (unitless)		0.48
Freq_HtM	Hand-to-mouth events per hour (events/hr)		13.9
BW	Body Weight (kg)	Children 1 < 2 years old	11

Post-application Object-to-Mouth Exposure Algorithm

Exposure from object-to-mouth activity is calculated as follows (based on the algorithm utilized in SHEDS-Multimedia):

$$E = [OR^* CF1 * SAM_O * (ET * N\_Replen) * (1- (1- SE_O)^{(Freq\_OtM/N\_Replen)})]$$

where:

E = exposure (mg/day);
OR = chemical residue loading on the object on day "t" (ug/cm^2);
CF1 = weight unit conversion factor (0.001 mg/µg);
SAM_O = area of the object surface that is mouthed (cm^2/event);
ET = exposure time (hr/day);
N_Replen = number of replenishment intervals per hour (intervals/hour);
SE_O = saliva extraction factor (i.e., mouthing removal efficiency); and
Freq_OtM = number of object-to-mouth contact events per hour (events/hour).

and

$$OR = AR * F_O * CF2 * CF3$$

where:

OR = chemical residue loading on the object (µg/cm^2);
AR = application rate (lbs ai/ft^2 or lb ai/acre);
F_O = fraction of residue available on the object (unitless);
CF2 = weight unit conversion factor (4.54 x 10^8 µg/lb); and
CF3 = area unit conversion factor (1.08 x 10^{-3} ft^2/cm^2 or 2.47 x 10^{-8} acre/cm^2).

Dose, normalized to body weight, is calculated as:

$$D = \frac{E}{BW}$$

where:

D = dose (mg/kg-day);
E = exposure (mg/day); and
BW = body weight (kg).

Table A-X: Outdoor Residential Misting Systems – Inputs for Residential Post-application Object-to-Mouth Exposure			
Algorithm Notation	**Exposure Factor (units)**		**Point Estimate(s)**
AR	Application rate (to turf) (mass active ingredient per unit area)		**[input]**
F_O	Fraction of AR as OR following application [1]		0.01
SAM_O	Surface area of object mouthed (cm^2/event)		10
N_Replen	Replenishment intervals per hour (intervals/hour)		4
SE_O	Saliva extraction factor (fraction)		0.48
ET	Exposure time (hours per day)		1.5
Freq_OtM	Object-to-mouth events per hour (events/hr)		8.8
BW	Body Weight (kg)	Children 1 < 2 years old	11
[1] This SOP assumes that all of the residue on the turf could be transferred to the object (e.g., object residue is equal to turf transferable residue).			

Post-application Incidental Soil Ingestion Exposure Algorithm

Exposure from incidental soil ingestion is calculated as follows:

$$E = SRt * SIgR * CF1$$

where:
E = exposure (mg/day);
SRt = soil residue on day "t" (µg/g);
SIgR = ingestion rate of soil (mg/day); and
CF1 = weight unit conversion factor (1×10^{-6} g/µg).

and

$$SRt = AR * FS * (1-F_D)^t * CF2 * CF3 * CF4$$

where:

SR_t = soil residue on day "t" (µg/g);
AR = application rate (lbs ai/ft^2 or lb ai/acre);
FS = fraction of ai available in uppermost cm of soil (fraction/cm);
F_D = fraction of residue that dissipates daily (unitless);
T = post-application day on which exposure is being assessed;
CF2 = weight unit conversion factor (4.54×10^8 µg/lb);

CF3 = area unit conversion factor (1.08×10^{-3} ft^2/cm^2 or 2.47×10^{-8} $acre/cm^2$); and
CF4 = soil volume to weight unit conversion factor (0.67 cm^3/g soil).

Dose, normalized to body weight, are calculated as:

$$D = \frac{E}{BW}$$

where:

D = dose (mg/kg-day);
E = exposure (mg/day); and
BW = body weight (kg).

Table A-X: Outdoor Residential Misting Systems – Inputs for Residential Post-application Incidental Soil Ingestion Exposure

Algorithm Notation	Exposure Factor (units)		Point Estimate(s)
AR	Application rate (mass active ingredient per unit area)		**[input]**
FS	Fraction of AR available in uppermost 1 cm of soil (unitless)		1
F_D	Daily residue dissipation (fraction)		0.1
SIgR	Soil ingestion rate (mg/day)		50
BW	Body weight (kg)	Children 1 < 2 years old	11

2.2.3. Animal Barn Misting Systems

Post-Application Inhalation Exposure Algorithm

The following algorithm is used to determine post-application inhalation exposure from animal barn misting systems:

$$E = \frac{IR \cdot C_0 \cdot ET \cdot PR}{ACH}$$

where:

E = exposure (mg/day);
IR = inhalation rate (m^3/hr);
ACH = air changes per hour ($hour^{-1}$);
C_0 = initial concentration (mg/m^3);
PR = pulse rate (sprays/hr); and
ET = exposure time (hrs/day).

If product-specific data are available, air concentration is the residue immediately after a spray, typically referred to as "time 0." This exposure scenario assumes that individuals are exposed to the air concentration immediately after the application event. However, if chemical-specific data are not available, the initial air concentration can be calculated using the following formula:

$$C_0 = AR * CF1 * CF2$$

where:

C_0 = initial air concentration (mg/m^3);
AR = application rate per spray event (lbs ai/ft^3);
CF1 = weight unit conversion factor (454,000 mg/lb); and
CF2 = volume unit conversion factor (35.3 ft^3/ 1.0 m^3).

If application rates are given on the product label, these rates should be used. Application rates are typically given on product labels in ounces per 1000 ft^3. The following equation can be used to convert the application rate from ounces product per 1000 ft^3 to pounds ai per ft^3:

$$AR = \frac{AR_{label} * A.I. * CF * D_{H2O}}{V_{NC}}$$

where:

AR = application rate per spray (lb ai/ ft^3);
AR_{label} = application rate on label (given as ounces per 1000 ft^3) (oz);
A.I. = percent active ingredient in product (%);
CF = volume unit conversion factor (1 gallon/128 ounces);
D_{H2O} = water density (lb/gal); and
V_{NC} = nozzle coverage volume (as stated on label) (1000 ft^3).

If application rate is not given on the label, it can be calculated as follows:

$$AR = \frac{A.I. * DR * GPM * SD * D_{H2O}}{V_{NC}}$$

where:

AR = application rate per spray (lb ai/ft^3);
A.I. = percent active ingredient in product (%);
DR = dilution rate (volume of product/volume of total solution);
GPM = nozzle flowrate (gal/min);
SD = spray duration (min);
D_{H2O} = water density (lb/gal); and
V_{NC} = nozzle coverage volume (ft^3).

Absorbed inhalation dose normalized to body weight is calculated as:

$$D = \frac{E * AF}{BW}$$

where:

D = dose (mg/kg-day);
E = exposure (mg/day);
AF = absorption factor (dermal and/or inhalation); and
BW = body weight (kg).

Table A-X: Animal Barn Misting Systems – Inputs for Residential Post-application Inhalation Exposure			
Algorithm Notation	**Exposure Factor (units)**		**Point Estimate(s)**
AR	Application rate per spray event (lb ai/ ft^3)		**[input]**
DR	Spray dilution rate (volume of product/ volume of total solution)		**[input]**
GPM	Nozzle flowrate (gal/min)		0.014
SD	Spray duration (min)		1
V_{NC}	Nozzle coverage volume (ft^3)		1,000 ft^3 per nozzle, or label specific
ACH	Air changes per hour ($hour^{-1}$)		4
D_{H2O}	Water density (lb/gal)		8.34
PR	Pulse Rate (sprays/hr)		1 spray event per hour
C_0	Initial air concentration (mg/m^3)		Calculated; Concentration at time "0"
ET	Exposure time (hr/day)	Adult	4
		Children 3 < 6 years old	2
IR	Inhalation rate (m^3/hour)	Adult	0.64
		Children 3 < 6 years old	0.42
BW	Body weight (kg)	Adult	80
		Children 3 < 6 years old	19

Post-application Hand-to-Mouth Exposure Algorithm

Exposure from hand-to-mouth activity is calculated as follows (based on algorithm utilized in SHEDS-Multimedia):

$$E = \left[HR * \ (F_M * \ SA_H) * \ (ET * N\_Replen) * \left(1 - (1 - SE)^{\frac{Freq\_HtM}{N\_Replen}} \right) \right]$$

where:

E = exposure (mg/day);
HR = hand residue loading (mg/cm^2);
F_M = fraction hand surface area mouthed / event (fraction/event);
ET = exposure time (hr/day);
SA_H = surface area of one hand (cm^2);
N_Replen = number of replenishment intervals per hour (intervals/hour);

SE = saliva extraction factor (i.e., mouthing removal efficiency); and
Freq_HtM = number of hand-to-mouth contacts events per hour (events/hour).

and

$$HR = \frac{Fai_{hands} * DE}{SA_H * 2}$$

where:
HR = hand residue loading (mg/cm^2);
Fai_{hands} = fraction ai on hands compared to total surface residue from jazzercise study (unitless);
DE = dermal exposure (mg); and
SA_H = typical surface area of one hand (cm^2).

and

Dose, normalized to body weight, is calculated as:

$$D = \frac{E}{BW}$$

where:
D = dose (mg/kg-day);
E = exposure (mg/day); and
BW = body weight (kg).

Table A-X: Animal Barn Misting Systems – Inputs for Residential Post-application Hand-to-Mouth Exposure

Algorithm Notation	Exposure Factor (units)		Point Estimate(s)
Fai_{hands}	Fraction of ai on hands from jazzercise study (unitless)		0.15
DE	Dermal exposure calculated in *Section* ***Error! Reference source not found.*** (mg)		Calculated
HR	Residue available on the hands (mg/cm^2)		Calculated
SA_H	Surface area of one hand (cm^2)	Children 3 < 6 years old	225
AR	Application rate (mass active ingredient per unit area)		**[input]**
F_M	Fraction of hand mouthed per event (fraction/event)		0.13
N_Replen	Replenishment intervals per hour (intervals/hr)		4

Table A-X: Animal Barn Misting Systems – Inputs for Residential Post-application Hand-to-Mouth Exposure			
Algorithm Notation	**Exposure Factor (units)**		**Point Estimate(s)**
ET	Exposure time (hours per day)	Children 3 < 6 years old	2
SE	Saliva extraction factor (fraction)		0.48
Freq_HtM	Hand-to-mouth events per hour (events/hr)	Children 3 < 6 years old	14
BW	Body Weight (kg)	Children 3 < 6 years old	19

2.3 Indoor Environments

Post-Application Inhalation Exposure Algorithms

Exposure to pesticide aerosols

In order to assess post-application inhalation exposure to pesticide aerosols from indoor space sprays (e.g., flying insect killers), the initial air concentration must first be calculated. If chemical-specific data are available, the initial air concentration is the air concentration at time 0 (assuming that individuals could be exposed to the air concentration immediately after application). If data are not available, then the initial air concentration can be calculated using the following formula:

$$C_0 = AR * CF1$$

where:

C_0 = initial air concentration (mg/m^3);
AR = application rate (lbs ai/m^3); and
CF1 = conversion factor (454,000 mg/lb).

If an application rate is given on the label in terms of unit area, this should be used. The following equation can be used to calculate the application rate if it's not provided:

$$AR = \frac{AI * V_{product} * D_{product} * CF1 * CF2}{V_{room}}$$

where:

AR = application rate (lbs ai/m^3);
A.I. = percent active ingredient in product (% ai);
$V_{product}$ = volume of product in 1 can (mL);

$D_{product}$ = density of product (g/mL);
CF1 = conversion factor (1,000 mg/g);
CF2 = conversion factor ($2.2x10^{-6}$ lb/mg); and
V_{room} = volume of room (m^3).

The following algorithm is used to determine post-application inhalation exposure from indoor space sprays:

$$E = \frac{C_0 * IR}{ACH} * \left[1 - e^{(-ACH*ET)}\right]$$

where:
E = exposure (mg/day);
C_o = initial concentration (mg/m^3);
IR = inhalation rate (m^3/hr);
ACH = air changes per hour ($hour^{-1}$); and
ET = exposure time (hr/day).

Absorbed inhalation dose normalized to body weight is calculated as:

$$D = \frac{E * AF}{BW}$$

where:
D = dose (mg/kg-day);
E = exposure (mg/day);
AF = absorption factor (inhalation); and
BW = body weight (kg).

Exposure to pesticide vapors
The following algorithm is used to determine post-application inhalation exposure from indoor surface-directed sprays:

$$E = \frac{IR * M_{label}}{ACH * V_{room}} \left[1 - \left(\frac{(ACH * e^{-k*ET}) - (k * e^{-ACH*ET}}{ACH - k}\right)\right]$$

where:
E = exposure (mg/day);
IR = inhalation rate (m^3/hr);
M_{label} = mass of active ingredient applied, determined from product label (mg);
V_{room} = volume of room (m^3);
ACH = air exchanges per hour (1/hr);

k = first order decay rate (1/hr); and
ET = exposure time (hr).

In the above equation, a mass of pesticide is applied to a surface and the emission of the pesticide from the surface is assumed to decline over time due to dissipation of the pesticide (i.e., emission from the treated surface and removal due to the air exchange rate). The mass of active ingredient applied can be calculated using the following formula:

$$M_{label} = AR * A * CF1$$

where:
M_{label} = mass of active ingredient applied, determined from product label (mg);
AR = application rate (e.g., lb ai/ft^2, lb ai/gal);
A = area treated or amount handled (e.g., ft^2/day, gal/day); and
CF1 = conversion factor ($4.54x10^5$ mg/lb).

The exposure equation models an emission rate that decreases over time, which is based on a first-order decay rate constant (k). Evans (1994) proposed calculating such a decay rate based on work done by Chinn (1981). Chinn developed the following relationship between the volatility, or saturation concentration (C_{sat}), of a chemical and the time required for 90% of the chemical to evaporate (EvapT):

$$EvapT = 10^{[7.3698 - 0.9546 * log_{10}(C_{sat})]}$$

where:
EvapT = evaporation time (sec); and
C_{sat} = saturation concentration (mg/m^3).

Evans proposed the following equation to calculate the decay rate (or dissipation rate) that defines the change in the emission rate based on the evaporation time described by Chinn:

$$k = \frac{\ln(0.1) * CF1}{EvapT}$$

where:
k = first order decay rate (1/hr),
CF1 = conversion factor (sec/hr), and
EvapT = evaporation time (sec).

*****Saturation concentration verification*****
In the vapor emission assessment, post-application inhalation exposure occurs from the release of vapors following a surface treatment indoors. The concentration of pesticide in the air is

modeled over time to calculate exposure. **The maximum concentration allowed in the air should be the saturation concentration, calculated as a function of the pesticide's molecular weight and vapor pressure. The equation used to model the air concentration is not bound by the saturation concentration; therefore, the reviewer must perform a check to make sure the exposures being calculated are valid.**

The exposure equation above is based on the mass of pesticide applied, not the concentration of the pesticide in the air; therefore, the reviewer must check that the input for mass applied (M_{label}) is predicting an air concentration less than or equal to the saturation concentration. The following equation can be used to calculate the theoretical mass applied that would result in an air concentration that reaches the saturation concentration for a pesticide (M_{Csat}):

$$M_{C_{sat}} = \frac{C_{sat} * (ACH - k) * V}{k}$$

M_{Csat} should be compared to M_{label}.

- If $M_{label} > M_{Csat}$ → M_{label} <u>will</u> predict an air concentration higher than the saturation concentration. Use M_{Csat} in the exposure calculation.

- If $M_{label} < M_{Csat}$, → M_{label} <u>will not</u> predict an air concentration higher than the saturation concentration. Use M_{label} in the exposure calculation.

Once the post-application inhalation exposure is calculated, the inhalation dose normalized to body weight is calculated as:

$$D = \frac{E * AF}{BW}$$

where:

D = dose (mg/kg-day);
E = exposure (mg/day);
AF = absorption factor (inhalation); and
BW = body weight (kg).

Table A-X: Indoor Environments – Inputs for Residential Post-application Inhalation Exposure			
Algorithm Notation	**Exposure Factor (units)**		**Point Estimate(s)**
Generic Variables Used in Calculating Post-application Inhalation Exposure			
IR	Inhalation rate (m^3/hour)	Adult	0.64
		Children 1 < 2 years old	0.33

Table A-X: Indoor Environments – Inputs for Residential Post-application Inhalation Exposure			
Algorithm Notation	**Exposure Factor (units)**		**Point Estimate(s)**
ACH	Air changes per hour (hr^{-1})		0.45
BW	Body weight (kg)	Adult	80
		Children 1 < 2 years old	11
V_{room}	Volume of room (m^3)		33
Variables Specific to Post-application Inhalation Exposure to Pesticide Aerosols			
C_o	Initial air concentration (mg/m^3)		Calculated; concentration at time "0"
AR	Application rate (lb ai/ ft^3)		**[input]**
A.I.	Percent ai in product (%)		**[input]**
$V_{product}$	Volume of product (mL)		**[input]**
$D_{product}$	Product density (g/mL)	Water-based products	1
		Solvent-based products	0.8
ET	Exposure time (hr/day)		2
Variables Specific to Post-application Inhalation Exposure to Pesticide Vapors			
C_{sat}	Saturation concentration (mg/m^3)		Calculated
VP	Vapor pressure (mmHg)		**[input]**
MW	Molecular weight (g/mol)		**[input]**
R	Gas constant (L-atm/mol-K)		0.0821
T	Temperature of the air (kelvin, K)		298
M_{label}	Mass of active ingredient applied (mg)		**[input]**
k	First order decay rate		Calculated
ET	Exposure time (hr/day)	Adult	16
		Children 1 < 2 years old	18

Termiticide Applications (Foundation and Soil Injection)

For termiticide applications, the MCCEM model can be used to estimate exposures. The input of emission rate is necessary and is based on the Chinn evaporation time, as follows:

$$CET = \frac{145}{(MW * VP)^{0.9546}}$$

where:

CET = Chinn evaporation time (hr);

MW = molecular weight of pesticide active ingredient (g/mol); and
VP = vapor pressure (mmHg).

The emission rate (g/hr) is then calculated using the following formula:

$$ER = \frac{M}{CET}$$

where:

ER = emission rate (g/hr);
M = mass of chemical that penetrates house; and
CET = Chinn evaporation time (hr).

Post-application inhalation dose normalized to body weight is calculated as:

$$D = \frac{ADC * IR * ET * AF}{BW}$$

where:

D = dose (mg/kg-day);
ADC = average daily concentration (mg/m^3);
IR = inhalation rate (m^3/hr);
ET = exposure time (hr);
AF = absorption factor (inhalation); and
BW = body weight (kg).

Post-application Hand-to-Mouth Exposure Algorithm

Exposure from hand-to-mouth activity is calculated as follows (based on algorithm utilized in SHEDS-Multimedia):

$$E = \left[HR * (F_M * SA_H) * (ET * N\_Replen) * \left(1 - (1 - SE)^{\frac{Freq\_HtM}{N\_Replen}}\right)\right]$$

where:

E = exposure (mg/day);
HR = hand residue loading (mg/cm^2);
F_M = fraction hand surface area mouthed / event (fraction/event);
ET = exposure time (hr/day);
SA_H = surface area of one hand (cm^2);
N_Replen = number of replenishment intervals per hour (intervals/hour);
SE = saliva extraction factor (i.e., mouthing removal efficiency); and

Freq_HtM = number of hand-to-mouth contacts events per hour (events/hour).

and

$$HR = \frac{Fai_{hands} * DE}{SA_H * 2}$$

where:

HR = hand residue loading (mg/cm^2);
Fai_{hands} = fraction ai on hands compared to total surface residue from jazzercise study (unitless);
DE = dermal exposure (mg); and
SA_H = typical surface area of one hand (cm^2).

and

Dose, normalized to body weight, is calculated as:

$$D = \frac{E}{BW}$$

where:

D = dose (mg/kg-day);
E = exposure (mg/day); and
BW = body weight (kg).

Table A-X: Indoor Environments – Inputs for Residential Post-application Hand-to-Mouth Exposure			
Algorithm Notation	**Exposure Factor (units)**		**Point Estimate(s)**
Fai_{hands}	Fraction of ai on hands from jazzercise study (unitless)		0.15
DE	Dermal exposure calculated in *Section* ***Error! Reference source not found.*** (mg)		Calculated
HR	Residue available on the hands (mg/cm^2)		Calculated
SA_H	Surface area of one hand (cm^2)	Children 1 < 2 years old	150
AR	Application rate (mass active ingredient per unit area)		**[input]**
F_M	Fraction of hand mouthed per event (fraction/event)		0.13
N_Replen	Replenishment intervals per hour (intervals/hr)		4

Table A-X: Indoor Environments – Inputs for Residential Post-application Hand-to-Mouth Exposure				
Algorithm Notation	**Exposure Factor (units)**			**Point Estimate(s)**
ET	Exposure time (hours per day)	Children 1 < 2 years old	Carpets	4
			Hard Surfaces	2
SE	Saliva extraction factor (fraction)			0.48
Freq_HtM	Hand-to-mouth events per hour (events/hr)	Children 1 < 2 years old		20
BW	Body Weight (kg)	Children 1 < 2 years old		11

Post-application Object-to-Mouth Exposure Algorithm

Exposure from object-to-mouth activity is calculated as follows (based on algorithm utilized in SHEDS-Multimedia):

$$E = OR * CF1 * SAM_O * (ET * N\_Replen) * \left(1 - (1 - SE)^{\frac{Freq\_OtM}{N\_Replen}}\right)$$

where:

E	=	exposure (mg/day);
OR	=	chemical residue loading on an object (μg/cm^2);
CF1	=	weight unit conversion factor (0.001 mg/μg);
SAM_O	=	area of the object surface that is mouthed (cm^2/event);
ET	=	exposure time (hr/day);
N_Replen	=	number of replenishment intervals per hour (intervals/hour);
SE	=	saliva extraction factor (i.e., mouthing removal efficiency); and
Freq_OtM	=	number of object-to-mouth contact events per hour (events/hour).

and

$$OR = DepR * F_O$$

where:

OR	=	chemical residue loading on the object (μg/cm^2);
DepR	=	deposited residue (μg/cm^2); and
F_O	=	fraction of residue transferred to an object (unitless).

and

Oral dose, normalized to body weight, is calculated as:

$$D = \frac{E}{BW}$$

where:

D = dose (mg/kg-day);
E = exposure (mg/day); and
BW = body weight (kg).

Table A-X: Indoor Environments – Inputs for Residential Post-application Object-to-Mouth Exposure				
Algorithm Notation	**Exposure Factor (units)**			**Point Estimate(s)**
AR	Application rate (mass active ingredient per unit area)			**[input]**
F_O	Fraction of residue transferred to an object	Carpets		0.06[a]
		Hard surfaces		0.08[a]
SAM_O	Surface area of object mouthed (cm^2/event)			10
N_Replen	Replenishment intervals per hour (intervals/hour)			4
SE_O	Saliva extraction factor			0.48
ET	Exposure Time (hours per day)	Children 1 < 2 years old	Carpets	4
			Hard Surfaces	2
Freq_OtM	Object-to-mouth events per hour (events/hour)	Children 1 < 2 years old		14
BW	Body Weight (kg)	Children 1 < 2 years old		11

2.4 Treated Pets

Post-application Hand-to-Mouth Exposure Algorithm

Exposure from hand-to-mouth activity is calculated as follows (based on algorithm utilized in SHEDS-Multimedia):

$$E = [HR * (F_M * SA_H) * (ET * N\_Replen) * (1- (1- SE)^{(Freq\_HtM/N-Replen)})]$$

where:

E = exposure (mg/day);

HR = hand residue loading (mg/cm^2);
SA_H = surface area of one child hand (cm^2);
F_M = fraction hand surface area mouthed /event (fraction/event);
ET = exposure time (hr/day);
N_Replen = number of replenishment intervals per hour (intervals/hour);
SE = saliva extraction factor (i.e., mouthing removal efficiency); and
Freq_HtM = number of hand-to-mouth contacts events per hour (events/hour).

and

$$HR = \frac{E * Fai_{hands}}{2 * SA_H}$$

where:
HR = hand residue loading (mg/cm^2);
E = dermal exposure (mg);
Fai_{hands} = fraction of a.i. on hands compared to total residue from dermal transfer coefficient study (unitless); and
SA_H = surface area of one child hand (cm^2).

Oral dose, normalized to body weight, is calculated as:

$$D = \frac{E}{BW}$$

where:
D = dose (mg/kg-day);
E = exposure (mg/day); and
BW = body weight (kg).

Table A-X: Treated Pets – Inputs for Residential Post-application Hand-to-Mouth Exposure

Algorithm Notation	Exposure Factor (units)		Point Estimate(s)
Fai_{hands}	Fraction of a.i. on hands from transfer coefficient studies (unitless)		Solid = 0.37 Liquid = 0.040
F_M	Fraction hand surface area mouthed /event (fraction/event)		0.13
N_Replen	Replenishment intervals per hour (intervals/hr)		4
ET	Exposure time (hours/day)	Children 1 < 2 years old	1.0
SE	Saliva extraction factor		0.48
Freq_HtM	Hand-to-mouth events per hour (events/hr)	Children 1 < 2 years old	20
SA_H	Typical surface area of one child hand (cm^2)	Children 1 < 2 years old	150

Table A-X: Treated Pets – Inputs for Residential Post-application Hand-to-Mouth Exposure			
BW	Body Weight (kg)	Children 1 < 2 years old	11

2.5 Impregnated Materials

Non-Dietary Object-to-Mouth Ingestion Algorithm (textiles only)

Exposure from object-to-mouth activity is calculated as follows (based on algorithm utilized in SHEDS-Multimedia):

$$E = OR * CF1 * SAM_O * (ET * N\_Replen) * \left(1 - (1 - SE_O)^{\frac{Freq\_OtM}{N\_Replen}}\right)$$

where:

E	= exposure (mg/day);
OR	= chemical residue loading on an object (µg/cm^2);
CF1	= weight unit conversion factor (0.001 mg/µg);
SAM_O	= area of the object surface that is mouthed (cm^2/event);
ET	= exposure time (hr/day);
N_Replen	= number of replenishment intervals per hour (intervals/hour);
SE_O	= saliva extraction factor (i.e., mouthing removal efficiency); and
Freq_OtM	= number of object-to-mouth contact events per hour (events/hour).

and

$$OR = SR * F_O$$

where:

OR	= chemical residue loading on the object (µg/cm^2);
SR	= surface residue (µg/cm^2); and
F_O	= fraction of residue available on the object (unitless).

Non-dietary oral dose, normalized to body weight, is then calculated as:

$$D = \frac{E * AF}{BW}$$

where:

D	= dose rate (mg/kg-day);
E	= exposure (mg/day);
AF	= oral absorption factor; and
BW	= body weight (kg).

Table A-X: Impregnated Materials – Inputs for Residential Post-application Object-to-Mouth Exposure		
Algorithm Notation	**Exposure Factor (units)**	**Recommended Value**

Table A-X: Impregnated Materials – Inputs for Residential Post-application Object-to-Mouth Exposure			
SR	Residue Concentration ($\mu g/cm^2$)		**[input]**
WF	Percent A.I. by Weight (WF) (% w/w)		**[input]**
MD	Material weight:surface area density (mg/cm^2)	Cotton	20
		Light Cotton/Synthetic Mix	10
		Heavy Cotton/Synthetic Mix	24
		All Synthetics	1
F_O	Fraction of AR as OR following application	Carpets	0.06
		Hard surfaces	0.08
SAM_O	Surface area of object mouthed per event (cm^2/event)		10
N_Replen	Replenishment intervals per hour (intervals/hour)		4
SE_O	Saliva extraction factor		0.48
ET	Exposure Time (hours per day)	Indoor Environments (Children 1 < 2 years old)	4
		Outdoor Environments (Children 1 < 2 years old)	1.5
Freq_OtM	Object-to-mouth events per hour (events/ hour)	Indoor Environments (Children 1 < 2 years old)	14
		Outdoor Environments (Children 1 < 2 years old)	8.8
BW	Body Weight (kg)	Children 1 < 2 years old	11

Non-Dietary Hand-to-Mouth Ingestion Exposure Algorithm (carpets, flooring, hard surfaces only)

Exposure from hand-to-mouth activity is calculated as follows (based on algorithm utilized in SHEDS-Multimedia):

$$E = \left[HR * (F_M * SA_H) * (ET * N\_Replen) * \left(1 - (1 - SE)^{\frac{Freq\_HtM}{N\_Replen}}\right)\right]$$

where:

E = exposure (mg/day);
HR = hand residue loading (mg/cm^2);
F_M = fraction hand surface area mouthed / event (fraction/event);
SA_H = surface area of one hand (cm^2);
ET = exposure time (hr/day);
N_Replen = number of replenishment intervals per hour (intervals/hour);
SE = saliva extraction factor (i.e., mouthing removal efficiency); and
Freq_HtM = number of hand-to-mouth contacts events per hour (events/hour).

In this algorithm, hand residue concentration is calculated as:

$$HR = SR * F_H$$

where:

HR = hand residue concentration (mg/cm^2);
SR = surface residue (μg/cm^2); and
F_H = fraction ai transferred to hands.

After calculating exposure, oral dose, normalized to body weight, is calculated as:

$$D = \frac{E}{BW}$$

where*:*

D = dose (mg/kg-day);
E = exposure (mg/day); and
BW = body weight (kg).

Table A-X: Impregnated Materials – Inputs for Residential Post-application Hand-to-Mouth Exposure				
Algorithm Notation	**Exposure Factor (units)**			**Point Estimate(s)**
SR	Surface Residue Concentration (mg a.i. /cm^2)			**[input]**
WF	Percent A.I. by Weight (WF) (% w/w)			**[input]**
MD	Material weight:surface area density (mg/cm^2)	Cotton		20
		Light Cotton/ Synthetic Mix		10
		Heavy Cotton/ Synthetic Mix		24
		All Synthetics		1
F_H	Fraction ai transferred to hands	Carpets		0.06
		Hard Surfaces		0.08
F_M	Fraction of hand mouthed per event (fraction/event)			0.13
SA_H	Typical surface area of one toddler hand (cm^2)			150
N_Replen	Replenishment intervals (intervals/hr)			4
ET	Exposure Time (hours per day)	Children 1 < 2 years old	Carpets	4
			Hard Surfaces	2
SE	Saliva extraction factor (fraction)			0.48
Freq_HtM	Hand-to-mouth events per hour (events/hour)	Children 1 < 2 years old		20
BW	Body Weight (kg)	Children 1 < 2 years old		11

2.6 Treated Paints and Preservatives

Non-Dietary Hand-to-Mouth Ingestion Exposure Algorithm

Exposure from hand-to-mouth activity is calculated as follows (based on algorithm utilized in SHEDS-Multimedia):

$$E = [HR * (F_M * SA_H) * (ET * N\_Replen) * (1- (1- SE)^{(Freq\_HtM/N-Replen)})]$$

where:

E	= exposure (mg/day);
HR	= hand residue loading (mg/cm^2);
F_M	= fraction hand surface area mouthed / event (fraction/event);
SA_H	= surface area of one hand (cm^2);
ET	= exposure time (hr/day);
N_Replen	= number of replenishment intervals per hour (intervals/hour);
SE	= saliva extraction factor (ie, mouthing removal efficiency); and
Freq_HtM	= number of hand-to-mouth contacts events per hour (events/hour).

In this algorithm, hand residue concentration is calculated as:

$$HR = SR * TE$$

where:

HR	= hand residue concentration (mg/cm^2);
SR	= surface residue (µg/cm^2); and
TE	= transfer Efficiency.

After calculating exposure, oral dose, normalized to body weight, is calculated as:

$$D = \frac{E}{BW}$$

where:

D	= dose (mg/kg-day);
E	= exposure (mg/day); and
BW	= body weight (kg).

Table A-X: Treated Paints and Preservatives – Inputs for Residential Post-application Hand-to-Mouth Exposure

Algorithm Notation	Exposure Factor (units)	Point Estimate(s)
SR	Surface Residue Concentration (mg a.i. /cm^2)	**[inputs]**
TE	Material-to-skin transfer efficiency	0.14
F_M	Fraction of hand mouthed per event (fraction/event)	0.13

Table A-X: Treated Paints and Preservatives – Inputs for Residential Post-application Hand-to-Mouth Exposure			
SA_H	Typical surface area of one hand, children 1 < 2 years old (cm^2)		150
N_Replen	Replenishment intervals (intervals/hr)		4
ET	Exposure Time (hours per day)	Indoor Environments (Children 1 < 2 years old)	4
		Outdoor Environments (Children 1 < 2 years old)	1.5
SE	Saliva extraction factor (fraction)		0.48
Freq_HtM	Hand-to-mouth events (events/hour)	Indoor Environments (Children 1 < 2 years old)	20
		Outdoor Environments (Children 1 < 2 years old)	13.9
BW	Body Weight (kg)	Children 1 < 2 years old	11

Post-application Inhalation Exposure Model (Wall Paint Exposure Model)

For the adult DIY painter, a 4-hr average air concentration (i.e., the time it takes to paint the bedroom) should be used in the following equation used for calculating the absorbed inhalation dose:

$$D = \frac{C * IR * ET * AF}{BW}$$

where:

D = Potential Daily Dose (mg/kg-day);
C = 4-Hour Average Air concentration (mg a.i./m^3);
IR = Inhalation rate (Standard Value= m^3/hour);
ET = Exposure time (Standard Value= hours/day);
AF = Absorption Factor; and
BW = Bodyweight (kg).

For the bystander/post-application exposure, the data in the "Conc@person" column of the output file should be used to estimate 24-hr average and subsequently used in the following equation for calculating the post-application absorbed inhalation dose is:

$$D = \frac{C * IR * ET * AF}{BW}$$

where:

D = Potential Daily Dose (mg/kg-day);
C = 24-Hour Average Air concentration (mg a.i./m^3);
IR = Inhalation rate (m^3/hour);
ET = Exposure time (hours/day);
AF = Absorption Factor; and

BW = Bodyweight (kg).

APPENDIX G. Summary of Occupational Non-Cancer Algorithms

Occupational Non-cancer Handler Algorithms

Potential daily exposures for occupational handlers are calculated using the following formulas:

$$E = UE * AR * A * 0.001\ mg/ug$$

where:

E	=	exposure (mg ai/day),
UE	=	unit exposure (µg ai/lb ai),
AR	=	maximum application rate according to proposed label (lb ai A or lb ai/gal), and
A	=	area treated or amount handled (e.g., A/day, gal/day).

The daily doses are calculated using the following formula:

$$ADD = \frac{E * AF}{BW}$$

where:

ADD	=	average daily dose absorbed in a given scenario (mg ai/kg/day),
E	=	exposure (mg ai/day),
AF	=	absorption factor (dermal and/or inhalation), and
BW	=	body weight (kg).

Margin of Exposure: Non-cancer risk estimates for each application handler scenario are calculated using a Margin of Exposure (MOE), which is a ratio of the toxicological endpoint to the daily dose of concern. The daily dermal and inhalation dose received by occupational handlers are compared to the appropriate POD (i.e., NOAEL) to assess the risk to occupational handlers for each exposure route. All MOE values are calculated using the following formula:

$$MOE = \frac{POD}{ADD}$$

where:

MOE	=	margin of exposure: value used by HED to represent risk estimates (unitless),
POD	=	point of departure (mg/kg/day), and
ADD	=	average daily dose absorbed in a given scenario (mg ai/kg/day).

Occupational Non-cancer Post-Application Algorithms

Potential daily exposures for occupational post-application workers are calculated using the following formulas:

$$DFR_t = AR * F * (1-D)^t * \left(4.54E8 \frac{ug}{lb}\right) * \left(2.47E\text{-}8 \frac{A}{cm^2}\right)$$

where:

DFR_t	=	dislodgeable foliage residue on day "t" (µg/cm^2),
AR	=	application rate (lb ai/acre),
F	=	fraction of ai retained on foliage or 25% (unitless),
D	=	fraction of residue that dissipates daily or 10% (unitless), and
t	=	number of days after application day (days).

$$E = TC * DFR_t * ET * 0.001 \frac{mg}{ug}$$

where:

E	=	exposure (mg ai/day),
TC	=	transfer coefficient (cm^2/hr),
DFR_t	=	dislodgeable foliar residue on day "t" (µg/cm^2), and
ET	=	exposure time (hours/day).

The daily doses are calculated using the following formula:

$$ADD = \frac{E * AF}{BW}$$

where:

ADD	=	average daily dose absorbed in a given scenario (mg ai/kg/day),
E	=	exposure (mg ai/day),
AF	=	absorption factor (dermal and/or inhalation), and
BW	=	body weight (kg).

Margin of Exposure: Non-cancer risk estimates for each scenario are calculated using a Margin of Exposure (MOE), which is a ratio of the toxicological endpoint to the daily dose of concern. The daily dermal dose received by occupational post-application workers is compared to the appropriate POD (i.e., NOAEL) to assess the risk to occupational post-application workers. All MOE values are calculated using the following formula:

$$MOE = \frac{POD}{ADD}$$

where:

MOE = margin of exposure: value used by HED to represent risk estimates (unitless),
POD = point of departure (mg/kg/day), and
ADD = average daily dose absorbed in a given scenario (mg ai/kg/day).

APPENDIX H. Summary of Occupational and Residential Cancer Algorithms

After the development of the ADD values, the next step required to calculate carcinogenic risk estimates is to amortize these values over the anticipated lifetime, which results in the LADD. LADD values are calculated using the following equation:

$$LADD = ADD * \frac{Days\ per\ Year\ of\ Exposure}{365\ Days\ per\ Year} * \frac{Years\ per\ Lifetime\ of\ Exposure}{Lifetime\ Expectancy}$$

where:

LADD	=	absorbed dose over a lifetime (mg ai/kg/day),
ADD	=	average daily dose absorbed in a given scenario (mg ai/kg/day),
Days per Year of Exposure	=	annual frequency of an application by an individual (days/year),
Years per Lifetime of Exposure	=	amount of a lifetime that an individual would be expected to use pesticides (years), and
Lifetime Expectancy	=	average life expectancy of an individual (years).

Cancer risk estimate calculations are completed by comparing the LADD values calculated above to the Q_1* for the chemical. Cancer risk estimates are calculated using the following equation:

$$Total\ Cancer\ Risk\ Estimate = (Dermal\ LADD + Inhalation\ LADD) * Q_1*$$

where:

Cancer Risk Estimate	=	probability of incidence of cancer cases over a lifetime (unitless),
Dermal LADD	=	absorbed dose from dermal exposure over a lifetime (mg ai/kg/day),
Inhalation LADD	=	absorbed dose from inhalation exposure over a lifetime (mg ai/kg/day), and
Q_1*	=	quantitative dose response factor used for linear, low-dose response cancer risk estimate calculations $(mg/kg/day)^{-1}$.